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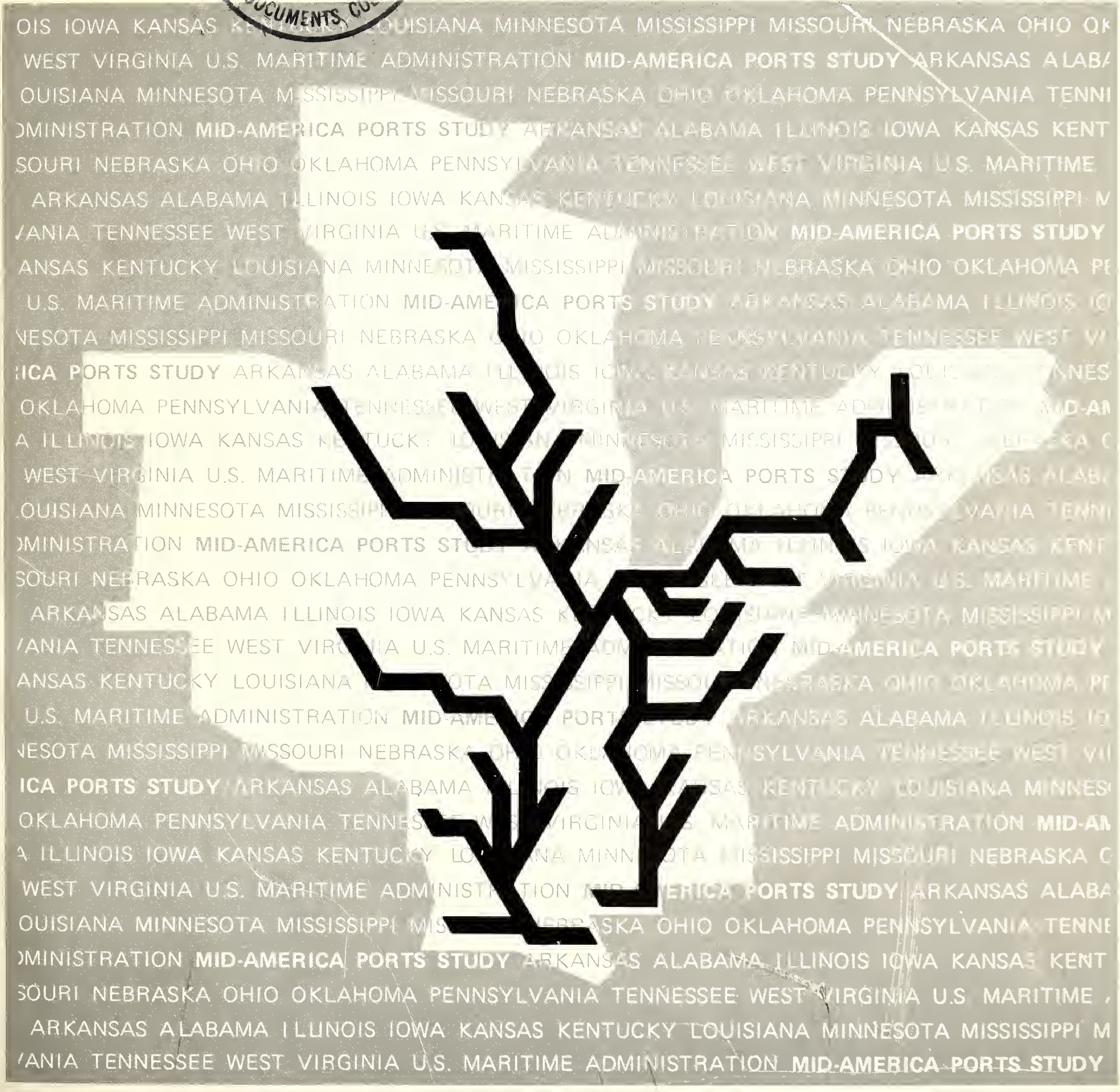
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VOLUME I
MAIN REPORT

U.S. DEPARTMENT OF COMMERCE

MID-AMERICA PORTS STUDY

FINAL REPORT

JUNE 1979

MARITIME ADMINISTRATION · DEPARTMENT OF COMMERCE
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June 11, 1979

The Steering Committee
Mid-America Ports Study

Dear Members:

In accordance with our Agreement of 21 April 1977 with the Maritime Administration, U. S. Department of Commerce, Tippetts-Abbett-McCarthy-Stratton (TAMS) submits herewith the Final Report, Mid-America Ports Study. Assisting TAMS in this effort were Temple, Barker & Sloane, Inc., Lexington, Massachusetts; Chase Econometric Associates, Inc., Bala Cynwyd, Pennsylvania; and the Institute of Public Administration, Washington, D.C.

The Report comprises 19 volumes: Volume 1, herein, contains the Main Report; Volume 2 the General Appendices; and Volumes 3 through 19 the detailed study findings for each of the 17 participating states. An executive report presenting highlights of the study is contained in a separate volume. A brief summary of the results of the study follows:

Mid-America's Ports: Conservation and Energy

There is strong economic justification for inland waterway transportation. The reduction in transport costs, opening up of areas, and increases in job opportunities have been shown by many different studies. Less tangible but nonetheless real benefits arise from the land conservation features of planned port development and from the energy conservation features of water transport.

Conservation of waterfront land is rarely complementary with commercial waterway development. The pursuit of one can conflict with the other. But on Mid-America's inland waterways, proper port and terminal development is the way to promote riverfront conservation.

Historically, sites for terminals were selected primarily because they were readily accessible to rail and roads. Land use, regional development needs, and environmental concerns were secondary considerations. As a result, these facilities are strung along Mid-America's river network. This approach, though an embodiment of America's independent economic spirit, is not the most efficient use of increasingly precious riverfront.

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Coordinated development of marine terminals could provide benefits for both the public and private sectors. Coordinated terminal grouping would conserve a dwindling natural resource without violating the independence of terminal owners. Facility grouping would also conserve fuel and time. Towing, fleeting and security would become more efficient, as would services such as spill clean up.

Coordinated plans for the development of Mid-America's inland ports would see a rare and happy union of conservation and development.

Conservation of energy is a major benefit that derives from inland waterway development. Barges are more energy efficient than either railroads or intercity trucks. It has been estimated that waterways transportation of freight provides 250 ton miles of transport per gallon of fuel in comparison to rail with 200 ton miles per gallon and truck with 58 ton miles per gallon. The inland waterways are currently being utilized for the transport of 230 million tons of energy products annually. By the year 2000, waterways will be transporting 490 million short tons of these products annually. As the nation's first fossil fuel returns to favor, coal traffic on the inland waterways will increase dramatically. In the years ahead, low sulphur western coal will be increasingly transshipped by rail to barge to serve mid-western and southern markets. At present, the waterways of Mid-America's 17 states are carrying 440 million tons of cargo, or approximately one-quarter of the nation's total waterborne foreign imports and exports and domestic commerce. The nation must transport its energy commodities, and all commodities, in the most efficient manner possible.

Waterborne transport through the Mid-America ports and waterways system presents the nation with the most attractive alternative. It is essential, therefore, to establish a framework for action that will insure the most effective development of the waterway system.

Organization and Scope of Study

The Mid-America Ports Study is a joint effort of 17 Mid-America states and the Maritime Administration of the U. S. Department of Commerce. These states and the Maritime Administration jointly financed and directed the study and participated in data collection, analysis, and review.

The study focuses on river port developments and commerce movements along the 15,000 miles of waterway within the study area. To evaluate these developments, the study includes investigations of railroads and pipelines, marine transportation technology, and capacities and operations of the numerous locks and dams and channels on the inland waterway system.

Information on the existing marine terminals located along the Mid-America Waterway System was collected by each of the states participating in the study. These data were tabulated by the Maritime Administration.

The Past and the Present: Waterways of Mid-America

National interest in the navigable waters of Mid-America is as old as our nation. In 1787 the Continental Congress declared the navigable waters leading into and between the St. Lawrence and Mississippi Rivers to be common highways open to all on equal terms. In 1789 the Federal Government made the first improvements to the harbors and waterways.

Today, Mid-America's waterways on the Mississippi River System, Gulf Coast Waterways, and Alabama Rivers comprise 15,000 miles of navigable channels with 157 locks and dams; most channels on the waterways are maintained for navigation by barges with drafts up to nine feet.

This study identifies 13 locks and dams on the upper Mississippi, Illinois, Tennessee, and Ohio Rivers and the Gulf Intracoastal Waterway which will become constraints to the free movement of waterborne traffic before year 2000. Unless additional lock capacity is provided, cargo will be diverted from the waterways and the full multimodal potential of Mid-America's ports will not be realized.

The Present: Ports of Mid-America

As part of the comprehensive data collection effort for this study, the first detailed inventory of marine terminal facilities on Mid-America's waterways was conducted. Data were collected on approximately 1,200 marine terminals. Nearly 70 percent of the terminals handle a single cargo type. Single-purpose facilities handling refined petroleum products, grains and coal account for 40 percent of the region's waterway terminals. Mid-America's terminals use over 7,000 acres of land for the storage of general cargo and dry-bulk commodities. Additional areas are used for 340 million barrels of tank storage for liquid bulks and 355 million bushels of elevator storage for grains. The inland waterway terminals have almost 700 pieces of equipment for the handling of general cargo commodities, over 1,000 for dry-bulk commodities, over 300 for the handling of grains, and about 300 for liquid bulks.

The estimated annual cargo handling capacities of the Region's inventoried terminals are concentrated in six major commodities, as follows:

	Shipping Terminals	Receiving Terminals
Petroleum Products	210 million tons	310 million tons
Crude Petroleum	220 million tons	160 million tons
Coal	200 million tons	160 million tons
Chemicals	170 million tons	140 million tons
Grains	80 million tons	50 million tons
Fertilizers	50 million tons	40 million tons

Over 25 percent of the area's capacity is used for the loading and discharging of liquid bulk petroleum products. Crude petroleum facilities and coal handling facilities each account for approximately 17 percent of the region's total capacity. The states of Missouri and Illinois combined account for over 30 percent of the study area's handling capacity.

The Present and Future: Mid-America Waterway Commerce

Practically all of the 154 commodity types shipped in the United States move through Mid-America's inland port facilities. These were aggregated into 20 commodity categories for analysis.

Ports on the inland waterway system of Mid-America received 440 million tons of cargo and shipped an equal volume in 1976. Coal, petroleum and petroleum products, chemicals, grains, and fertilizers account for three-quarters of the total waterborne commerce on the system.

For forecasting commerce, more than 400,000 commodity flows were analyzed. Econometric models and other procedures were used for 20 commodity groups and 17 states (divided into 89 sub-regions). Account was taken of new waterway projects (e.g., Tennessee-Tombigbee Waterway, Red River), waterway user charges, lock and dam constraints, and changes in energy use patterns to produce a range of forecasts.

Study findings as they relate to forecast traffic include:

- Total waterborne traffic will double over the forecast period - increasing from 440 million short tons in 1976 to more than 900 million short tons in the year 2000, a 2.9 percent average annual increase.
- The following commodities will experience high growth:

	Year 1976	Year 2000
Grains	44 million tons	79 million tons
Coal	131 million tons	298 million tons
Petroleum products	87 million tons	152 million tons
Fertilizers	13 million tons	71 million tons
Chemicals	26 million tons	54 million tons

- The waterway user charge and the constraints imposed by the 13 locks and dams which reach capacity over the forecast period will reduce waterborne traffic by as much as 16 percent by the year 2000.
- The states of Oklahoma, Arkansas, Alabama, Wisconsin, and Minnesota will have the largest percentage increases in traffic.
- The states of Louisiana, Alabama, Illinois, and Missouri will have the largest absolute increase in traffic, accounting for almost 60 percent of the study area's growth between 1976 and the year 2000.

The Future: Port Needs In Mid-America

By the year 2000, cargo at Mid-America's ports will exceed existing capacity by almost 700 million tons annually. Significant capital investments will be required to accommodate these major increases and shifts in waterborne commerce. Coal alone will account for about 35 percent of the capacity deficiency; the utilization of the waterways system for the movement of western coal to midwestern and southern markets will require new handling terminals. Major new facilities will also be required for grains, petroleum products, fertilizers, and construction materials.

These needs are translated into investment, number of facilities and land requirements. Through the year 2000, the construction of new facilities to accommodate forecast commodity growth will require a capital investment of almost $9.5 billion, of which 40 percent will be expended in the State of Louisiana. This money will be needed for the construction of 1,000 new terminals and the development of 11,000 acres of land; additional acreage will be utilized by the industrial facilities served by these terminals. Over 100 miles of waterfront will be occupied by the new terminal facilities.

Investigation of alternative means of developing new facilities points to the desirability of clustering terminals to conserve waterfront land and minimize costs for infrastructure.

Major investments will be made for facilities handling the following commodities: petroleum products - $4.4 billion; coal - $2.2 billion; cash grains - $1.4 billion; fertilizers - $900 million; and chemicals - $770 million. Additional investments will be needed for barge fleeting and other facilities that support water transportation.

Institutions for Port Development

Riverfront development is a complex process in which Federal, state and local agencies interact with each other and with private enterprises engaged in water transportation. Federal interests alone may be represented by as many as a dozen agencies. Within the states,responsibility for riverfront development may be lodged with state agencies, autonomous port authorities, or local municipalites. (There is autonomy but also cooperation among these interests.) A more complicated and heavily used waterway system will require greater coordination among all participants.

During the next few decades developmental emphasis on the inland waterways will shift from navigation channels and harbors to port facilities. The waterway system is now largely in place. When the new waterways already under construction have been completed, configuration of the system will have been fixed for the foreseeable future.

The Federal mandate for promoting waterborne commerce rests on the Maritime Administration of the U. S. Department of Commerce. Section 8 of the Merchant Marine Act of 1920 directs the agency to promote, encourage and develop ports and transportation facilities for water commerce. The act requires the agency to study water terminals, including docks, warehouses, and related equipment; to provide advice to communities relevant to local planning for wharves, piers, and water terminal; and to investigate the practicability of harbor, river, and port improvements.

Federal policy has also clearly come to embrace cooperative planning with state governments through regional commissions and the river basin commissions established in accordance with Title II of the Water Resources Planning Act. In Mid-America, river basin commissions have been established in the Ohio, Upper Mississippi and Missouri basins.

State governments make significant contributions to port development on the inland waterway system by providing firm legislative authorities for exercise of local incentives. Twelve Mid-America states have general enabling statutes that authorize local governments to create port authorities. In three states riverport development is a responsibility assigned to agencies closely integrated with the structure of general government.

To promote proper development on Mid-America's waterways, in the future:

The Federal Government Should --

- Make grants to states to improve local, regional, and state planning for waterfront facilities on navigable inland waterways.

- Encourage states to make state riverport plans covering all communities on the inland waterway system.

- Provide research and analytical support for development of an efficient system of locally owned and administered waterfront facilities.

The State Government Should --

- Designate a principal agency to promote orderly development of riverfront facilities on navigable waters.
- Promote multimodal transportation planning and encourage intermodal coordination of transportation services.
- Cooperate with other states and the Federal Government in promoting effective riverport planning.
- Prepare statewide riverport plans.

The Local Port Authority Should --

- Develop a master plan for the port complex and the adjacent waterfront.
- Coordinate port projects and master plans with other community development efforts to ensure effective multiple use of waterway and waterfront resources.
- Participate fully in regional and state planning efforts, providing technical data and advice on the needs of shallow-draft carriage.
- Encourage the private sector to plan and construct facilities in accordance with port master plans.

* * *

TAMS wishes to acknowledge the valuable cooperation, assistance and encouragement received from all of Mid-America's inland waterways interests contacted in performance of the study and to express our sincere appreciation to the representatives of the states, the Maritime Administration, and other Federal and non-Federal agencies who participated in the Steering Committee briefings and reviews, for their helpful assistance and counsel during the course of the study.

Sincerely,

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U.S. Army Corps of Engineers

U.S. Department of Transportation

Ozarks Regional Commission

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

The Mid-America Ports Study covers inland waterborne commodity flows and port facilities in the Mississippi River Basin and the Gulf Intracoastal Waterway. It is the first comprehensive study undertaken in the United States that addresses the problems and potentials of Mid-America's 17-state inland river ports system. The study involved the unprecedented joint efforts of 17 states (Alabama, Arkansas, Illinois, Iowa, Kansas, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, Ohio, Oklahoma, Pennsylvania, Tennessee, West Virginia and Wisconsin) and the Maritime Administration, U.S. Department of Commerce (MarAd). The study began in May 1977 after two years of planning.

The area under study encompasses approximately one-third of the geographical area of the contiguous 48 states, and a significant share of the country's commerce moves from its inland ports. In 1976 over 440 million tons of waterborne cargo, equivalent to 25 percent of the nation's total domestic plus foreign import and export waterborne commerce, were transported in the study area. The principal commodities were coal, petroleum and petroleum products, grains, construction materials (sand and gravel), and chemicals, which accounted for about 75 percent of the total inland traffic by tonnage. They were transported in bulk form by the over 22,500 barges and tows of the inland waterway fleet.

Ports on the inland waterways, in contrast to their coastal counterparts, are not well defined. The key locational criteria are often a source of cargo production or consumption and the presence of a bluff or levee protected area secure from flooding and close to the navigational channels. Typically, the river banks are dotted with single purpose terminals developed by private interests, although concentrations do occur at urban areas.

Development of most inland port facilities has been accomplished in ways that have suited the convenience of individual users. There is minimal, if any, regional planning. Such development is wasteful of valuable land and infrastructure and represents inefficient use of regional resources. The focus of the study, therefore, is to provide the states and the Federal Government with an assessment of current and future needs, along with a database, for more effectively planning Mid-America's riverfront resources. In this regard, the principal concerns are to: identify future inland port cargo handling needs to accommodate forecast commerce movements and which reflect the utilization of improved cargo handling technologies, and formulate institutional mechanisms for implementing the required development program.

STUDY BACKGROUND

This study had its genesis in 1975. It developed out of a desire by the Port of New Orleans and the State of Louisiana to gain an insight into future demands for cargo handling facilities of all types along the Mississippi River within the state. In January of 1976, the Executive Director of the Port of New Orleans, on behalf of the Governors of Louisiana and 17 other states, submitted to the Assistant Secretary of Commerce for Maritime Affairs a proposal titled "Mid-America Ports Study." Governor Edwards of Louisiana solicited the Governors of the Mid-America states to participate in a cost-shared effort to study the impact of future maritime trade expected for the area. Sixteen states responded favorably and, along with Louisiana, committed funds which were matched by a Federal share from the Maritime Administration.

STUDY OBJECTIVES

The specific objectives of the study are to:

- Identify and assess conditions, problems and needs associated with the development of Mid-America's Mississippi River Basin commerce and the inland riverport system which serves this commerce.

- Develop a uniform information base that will provide improved understanding of conditions and improve the quality of analyses and bases for decision making.

- Identify the flows of cargoes in the system and forecast growth trends or shifts which might take place in future years as a result of demand growth, new technology and public policy decisions. The study is to look at both domestic and international trade entering and moving in the system.

- Identify classes of ports and port facilities and estimate the capacity of those facilities to cope with foreseen demands.

- Estimate needs for future facilities and recommend solutions to river port and related problems.

- Formulate policies, programs, general plans and specific recommendations for Federal, state and local governmental action.

The study provided for the collection of information that will be of value in assessing the capacity, utilization, adequacy and interrelationships of the region's river ports, its economic development and the regional port facility requirements to handle present and expected domestic and international commerce. It involves an analysis of the existing and planned transportation systems within Mid-America, their capabilities, limitations and ability to meet the region's future commercial needs to the year 2000. In this regard, changing trends in railroad, pipeline and waterborne transportation were given careful consideration.

It is particularly noteworthy that the nation's first integrated detailed inventory of inland port facilities was conducted for this study, through the joint efforts of the 17 participating states and MarAd. This computerized inventory of existing port terminals was used to project future port needs, as described in later chapters, and will be of use in subsequent, continuous port planning programs.

SCOPE OF STUDY

The inland waterways in the study area comprise:

1. The Mississippi River and tributaries, including the Minnesota, Missouri, Arkansas, Ouachita, Illinois Waterway, Ohio, Monongahela, Allegheny, Kanawha, Kentucky, Green, Cumberland, Tennessee Rivers and minor tributaries;

2. Waterways along the Gulf Coast, including the Gulf Intracoastal Waterway, Lake Charles, Calcasieu River, Sabine River, Atchafalaya River, Port Allen-Morgan City route, Pearl River and minor tributaries and outlets to the Gulf;

3. Alabama's river system including the Mobile, Tombigbee, Black Warrior, Alabama, Coosa and Chattahoochee Rivers and minor tributaries.

The study area shown in Figure 1 contains 1,200 inventoried terminal facilities and approximately 15,000 miles of waterway. There are 160 different waterborne commodities transported within the system. The study area is served by an extensive network of railroads and pipelines which both compete with and complement the waterways. The large number of facilities, the multi-modal nature of inland cargo and the geographic spread of the study area required the use of innovative analytical techniques; it was essential to keep the study manageable and to produce credible results .

For example, the basic premise of the approach utilized in the forecast of waterborne traffic is that the effort should focus on the marine mode and river ports; it was assumed that historic trends in modal split will continue unless factors change the relationship between trade and the choice of mode.

Competing modes and facilities were examined, therefore, only to the extent that factors were identified that might in the future alter the current market relationships. Under this method, waterborne traffic was forecast separately, using well established relationships with other econometric data. Adjustments to the forecasts were then made as required to reflect the influence of factors that will affect future competitive relationships, or significant departures from historic patterns: such adjustments included the introduction of western coal into the system, lock and dam capacity constraints, the waterway user charge and the construction of new waterways. Only if it was determined that excess capacity in a competing mode will be absorbed during the study period and a significant constraint to expansion of capacity exists, was further attention given to the impact of capacity of that particular route on modal split. If it was determined that excess capacity will not be absorbed or if it appeared that there is no constraint to increasing capacity while maintaining cost relationships between modes, then the impact of capacity on modal split for the particular route was not considered further. In other words, attention was focused on those areas where capacity constraints can be identified that are likely to impact on the ports system.

Innovative techniques were employed in dealing with the 1,200 terminal facilities in the port inventory and projecting future cargo handling needs. Extensive use was made of computer models and large databases. Never before had one port study, regional or otherwise,analyzed the cargo handling characteristics of so many port terminals. This was accomplished by preparing specifically for this effort computer programs which:

- Assessed, tabulated and analyzed the 17 state/ MarAd facility inventory;
- Tabulated two separate handling capacities for each terminal using inventory data and capacity equations and compared one to the other for the purpose of selecting the limiting capacity; and,

- Projected facility development cost, berth requirements and acreage for alternative growth scenarios.

The study was performed in three major phases:

- Definition
- Analysis and Forecast, and
- Assessment.

Each phase, in turn, was divided into a group of tasks; several subjects were covered in the Definition and Forecast phases, as follows:

- Economic and Demographic Data
- Commodity Movements
- Port Facilities
- Transportation Systems
- Shipping Technology
- Cargo Handling Systems
- Constraints and Institutional Structures

The output of the above was combined in the Assessment Phase to produce the final results of the study.

To facilitate the analysis, the study area was divided into planning regions, corresponding to each of the states and into 89 subregions; commodities and marine terminals were evaluated in groups.

A number of research and research-related efforts were undertaken to satisfy the study objectives. These efforts were largely designed to expand the current body of knowledge of the waterway system and to refine the databases and information already on hand. They covered such items as the commodity databases, econometrics, lock and dam capacity and terminal facility operations.

A 20-group commodity classification system based upon the 160 commodity groups contained in the Corps of Engineers Waterborne Commodity Statistics tabulations was developed specifically for this study. Each group is unique. It consists of commodities which have similar cargo handling characteristics and are also responsive to the same econometric factors. Such an approach expedited the forecasting process and simplified the terminal capacity evaluation.

Research was undertaken on the relationship between waterway commerce and national, regional and state econometric factors. Of particular note is the detailed analysis performed on grain and coal, which constitute together a major portion of the total inland waterway commerce. Major increases in future waterway coal movements are anticipated as a result of national energy policies and the introduction of western coal shipments. These items were researched to establish future commodity volumes.

A potential constraint to the movement of waterborne commodities is inadequate lock capacity. There are 157 locks in the inland waterway system and no uniformly agreed upon methodology for estimating lock capacity has been applied to the entire system. Therefore, in the interest of uniformity and building upon numerous past research efforts of the Corps of Engineers, the Consultant used a lock capacity methodology based upon queuing theory and acceptable tow delay levels.

To provide data input for the facility capacity analysis, Consultant staff conducted personal interviews with 70 terminal operators throughout the study area. Information on terminal operating characteristics representative of the different commodity groups was obtained.

CONDUCT OF STUDY

Responsibility for overall project management of the Mid-America Ports Study rested in its Steering Committee which consists of representatives of governors of the 17 states and the Maritime Administration. The management authority was exercised by the Steering Committee either directly or through its Executive Committee. Subcommittees appointed for specific purposes advised the Executive and Steering Committees.

Tippetts-Abbett-McCarthy-Stratton (TAMS), the prime contractor, conducted periodic reviews and briefing meetings before the Executive Committee or the Steering Committee and representatives of the study. Subcontractors to TAMS included Temple, Barker & Sloane, Inc. (TBS), who prepared the commerce forecasts and analysis of marine technology; Chase Econometric Associates, Inc. (CEAI), responsible for econometric analysis; and, the Institute of Public Administration (IPA), who addressed the institutional issues.

Maritime Administration representatives serve as coordinators between the contractor, the Chairman of the Steering and Executive Committees, and the participating states.

A total of five Steering Committee Briefings were conducted during the course of the study. Interim Study documents were prepared for each Briefing. The meetings were held as follows:

- St. Louis, Missouri (May 1977)
- Memphis, Tennessee (September 1977)
- New Orleans, Louisiana (January 1978)
- Minneapolis, Minnesota (July 1978)
- Washington, D.C. (March 1979)

ORGANIZATION OF FINAL REPORT

The Final Report consists of 19 volumes. Volume I is the main report which is presented herein. Volume II comprises the General Appendices (A through F), which contain detailed descriptions of selected study methodologies and findings of general interest to all study participants. Volumes 3 through 19 contain the detailed study findings for each participiping state -- each volume is state specific.

This Main Report contains 19 chapters, exclusive of the Introduction, divided into the three study phases:

- Definition Phase (Chapters 2 to 8);
- Analysis and Forecast Phase (Chapters 9 to 15);
- Assessment Phase (Chapter 16 to 18).

Conclusions and Recommendations are presented in the last chapter.

The consultant team worked under the direction and management of TAMS who had responsibility for integrating the work of the subcontractors into and preparing the Final Report. Chapter contributions of TAMS' subcontractors are noted below:

TBS - Chapters 2, 4, 6 (Rail), 7, 10 (Rail), 11 and 14.

CEAI- Chapters 3 and 13.

IPA - Chapters 9 and 19.

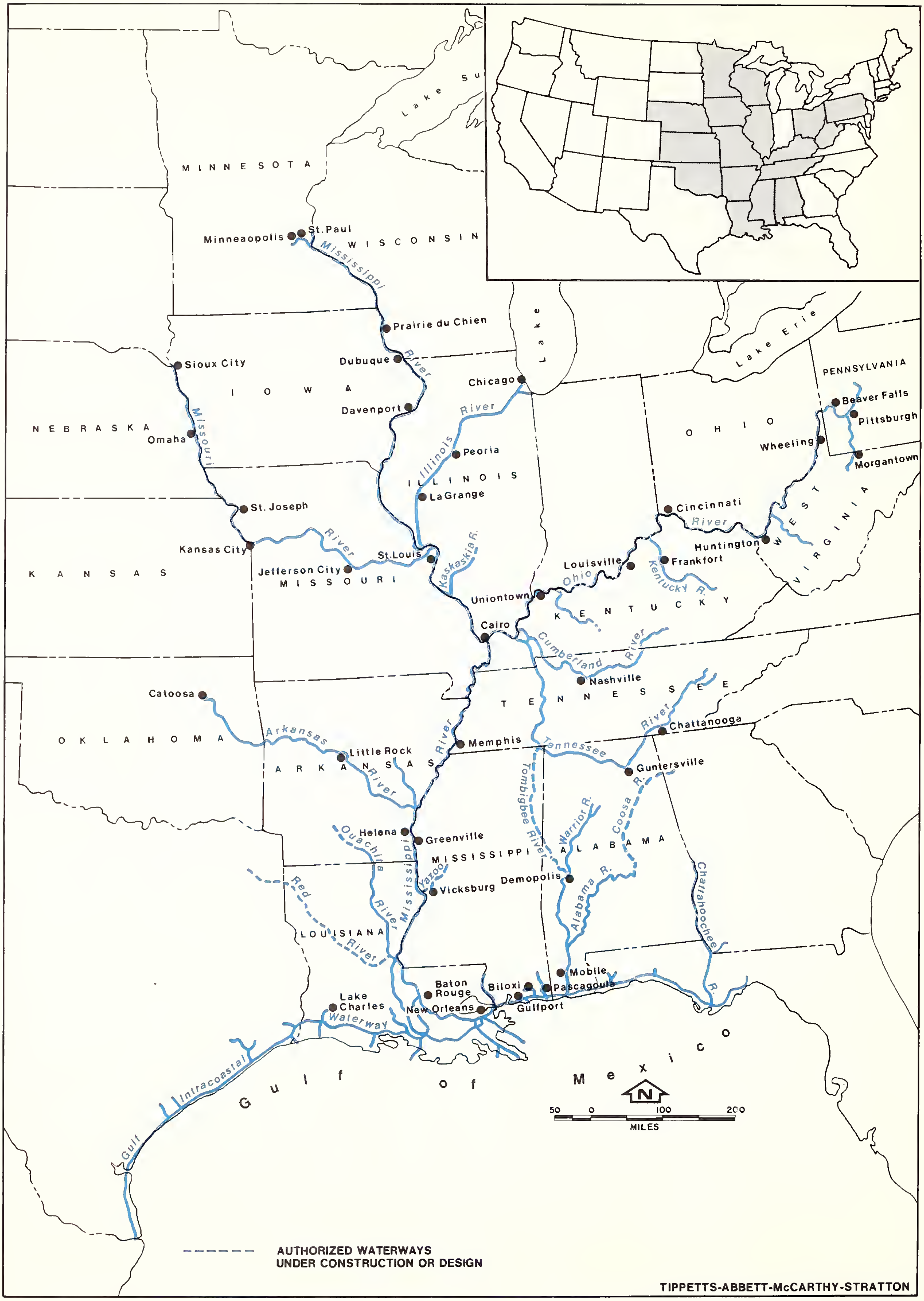

MINNESOTA
WISCONSIN
Lake Su
Minneaopolis
St. Paul
Mississippi
Prairie du Chien
Dubuque
River
Sioux City
IOWA
Davenport
Chicago
Lake
Lake Erie
PENNSYLVANIA
Beaver Falls
Pittsburgh
Morgantown
Wheeling
OHIO
NEBRASKA
Omaha
Missouri
River
Illinois
Peoria
ILLINOIS
LaGrange
St. Joseph
Cincinnati
River
Huntington
WEST VIRGINIA
Kansas City
River
St. Louis
Jefferson City
MISSOURI
KANSAS
Kaskaskia R.
Louisville
Frankfort
Ohio
Kentucky R.
Uniontown
KENTUCKY
Cairo
Cumberland
River
Nashville
TENNESSEE
Catoosa
OKLAHOMA
Arkansas
Little Rock
ARKANSAS
River
River
Memphis
River
Chattanooga
Tennessee
Guntersville
Tombigbee River
Warrior R.
Coosa R.
Helena
Greenville
Ouachita
River
Mississippi
MISSISSIPPI
ALABAMA
Yazoo
Vicksburg
Demopolis
Red
River
Alabama R.
Chattahoochee R.
LOUISIANA
Mobile
Baton Rouge
Biloxi
Pascagoula
Gulfport
Lake Charles
New Orleans
Waterway
Gulf Intracoastal
Gulf of Mexico
50 0 100 200
MILES
N
AUTHORIZED WATERWAYS
UNDER CONSTRUCTION OR DESIGN
TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 1 MID-AMERICA PORTS STUDY AREA

CHAPTERS 2 TO 8
DEFINITION PHASE (Existing Conditions)

FIGURE 1 MID-AMERICA PORTS STUDY AREA

CHAPTER 2

STUDY REGIONS AND SUBREGIONS

Historical and forecast commodity analyses and the port facility needs projections are performed for the subregion. The subregion is defined as a reach of river within a state. The navigable inland waterways in each of the 17 participating states were divided into subregions.

A programmable multi-tiered geographical description of commodity movements on the inland waterways has resulted from this effort. Over and above the needs of this study, the subregion provides a convenient basis for subsequent updating studies or for more detailed analyses which might be undertaken by the states or local planning entities.

METHODOLOGY

The Army Corps of Engineers collects domestic waterborne commerce statistics for the nation's coastal ports and inland waterways. The domestic commerce data, along with commerce data for foreign destinations and origins which are collected by the Bureau of the Census, are assigned to five-digit channel codes. Each channel code defines at a minimum (and most frequently) a single mile of waterway shoreline and the loading and discharging of commerce is reported for that mile. In certain cases the Corps of Engineers assigns one of several channels that define a port as a "port code" channel, which then is assigned the total tonnage of the channels within the port. In selected cases, the Corps of Engineers assigns a single channel to an entire project, river or multi-river system with all terminals, ports and tributaries. For each channel, the Corps' Waterborne Commerce Statistical Center (WCSC) compiles annual statistics for each commodity movement sent or received in that channel; commodity statistics are classified by Waterways Freight Bureau Commodity Classification for Shipping Statistics (CCSS).

Commodity statistics are published annually in the five-part series, Waterborne Commerce of the United States; Part 2 describes the Waterways and Harbors of the Gulf Coast, Mississippi River System and Antilles.

The Waterborne Commerce of the United States contains national summaries of waterway traffic as well as traffic summaries for the entire Mississippi River System, including the Illinois, Missouri, Ohio, Arkansas, and Tennessee Rivers and their tributaries. The Mid-America Ports Study arrangement of channels into waterways and harbors generally reflects the Corps of Engineers' assignment of channels to its divisions and districts and emphasizes entire rivers and large "equivalent" ports that include multi-port and multi-state locations.

The state-oriented approach of the Mid-America Ports Study required a recasting of the Army Corps channels into an entirely new system of port service regions that recognized political boundaries and the locations of terminal facilities. There are over 8,000 miles of waterways in the study area. They are often the boundary between two states, and terminals may be situated on both sides of a channel. This situation required a careful review and allocation of each channel to its proper geographical port service region.

Region and Subregion Designations

Each state was designated as a region for the purposes of this study and assigned a two-digit numerical code. The methodology employed in developing subregions entailed:

1. Assigning individual channels to a state based on the location of terminal facilities on a state's waterside of the channel.
2. Assigning these channels to port service regions on a case-by-case basis.

3. Grouping the port service regions, comprising one or more channels, into subregions within each state.

Each region corresponds to a state. Each state contains subregions. These subregions may be grouped into multistate super-regions for interstate planning and port development purposes.

Channel Identification

The basis of the port service regions are the thousands of channels that showed some cargo loading or discharge activity during any one of the years 1969-1976. Several source materials were used for identifying the individual channels in the study area, namely:

- The Army Corps of Engineers "Channel Master" Utility Report, July 1977, a record of all United States channels and waterways and harbor terminal facilities.
- The Army Corps of Engineers River Point Directory for the Mississippi River - Gulf Coast Inland Waterways Systems, May 1975 prepared for the Office, Chief of Engineers by the Hydraulics Laboratory, U.S. Army Engineers Waterways Experiment Station in Vicksburg, Mississippi.
- Flood Control and Navigation Charts and Maps, describing the waterways and harbors of the Mid-America Region. Charts prepared by the Army Corps of Engineers, Tennessee Valley Authority and National Oceanic and Atmospheric Administration National Ocean Survey.
- Inland River Guide, published annually by the "Waterways Journal", St. Louis. Used as a cross-reference to Army Corps of Engineers channel information, the guide provides precise mileage locations for the majority of terminals.
- For general reference, the Army Corps Civil Works Planning Division Map of the Mississippi River and Tributaries, Inland Waterways System - Port Equivalents, 1975 Edition was used.

These materials were used to assign each channel to one side of the waterway and to the appropriate state. Over 2,000 channels with terminals and tonnage shipments and receipts were compiled as described by their 5-digit CCSS codes. More than 1,400 additional channels without terminals but which supported midstream channel dredging, commercial sand and gravel dumping, and waterway improvements were assigned to the eastern and southern banks of all such channels and then to special ports which designate mid-channel activity. The following criteria governed the treatment of channels:

- Channels with both banks in one state and which had terminals, were assigned to the state in which they were located.
- Channels with banks in two states but with terminals only on one bank were assigned to the state with the terminals.
- Channels with terminals on banks in two states were reviewed on a case-by-case basis and assigned to one state on the basis of terminal locations and the majority of commodities handled.
- Channels which supported non-terminal activity were treated separately. Such locations were generally receiving commodities in Group 15 - Construction Materials, Group 16 - Mining Products, NEC, Group 10 - Lumber and Wood, and Group 20 - Waterways Improvement Materials. Some channels supported receipts of Groups 12 - Primary Ferrous and Nonferrous, comprised mainly of cargoes of sheet bulkhead material. These activities often do not require permanent terminal facilities, and move annually as river maintenance proceeds. These channels were,therefore, treated separately.

Channel-to-Port Assignment

The 2,000 facility channels identified were next assigned to ports or port equivalents for later allocation to subregions. In this manner over 300 ports, each assigned a unique four-digit port code, in the 17 Mid-America states were created.

Port-to-Subregion Assignment

The ports were developed as an interim step for use in the establishment of state subregions. In developing subregion boundaries, three basic criteria were employed:

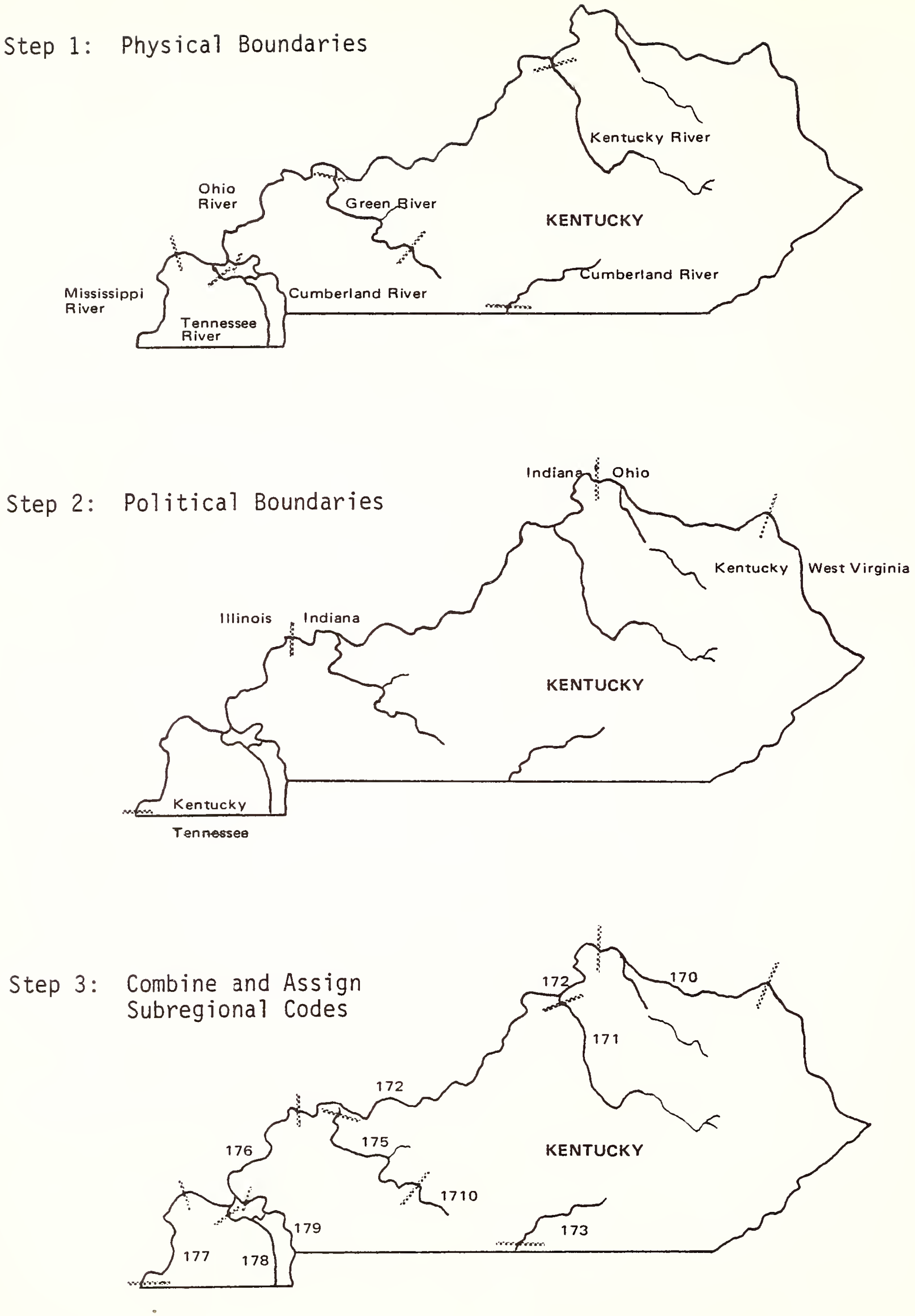
- Political boundaries of states, counties, and municipalities;
- Geographical and physical features including rivers, canals, waterways, locks, and changes in navigation drafts;
- Commodity volume movements;
- Selected locks and dams were used to break excessively long subregions; and,
- Not more than ten subregions could be established in any one state, to establish a practical and meaningful limitation on the level of detail and analytical requirements.

Application of these criteria resulted in:

- Subregions which are composed of ports and port equivalents stituated along only one major waterway; and
- Subregions which are delineated so as to align on both sides of a waterway.

The 89 subregions that evolved were assigned four-digit codes. The first two correspond to the state numeric code and the last to the sequentially numbered subregions within each state. The third digit is a filler. Figure 2 shows, as an example, the development of Kentucky's subregions.

Movements of waterway improvement materials or other commodities to and from channels occurred along a large number of channels, but amounted to less than 10 percent of all waterway tonnage. A separate system of dummy port and subregional assignments were developed to deal with these movements as a distinct activity at the subregional level.



Step 1: Physical Boundaries

Kentucky River
Ohio River
Green River
KENTUCKY
Mississippi River
Cumberland River
Cumberland River
Tennessee River

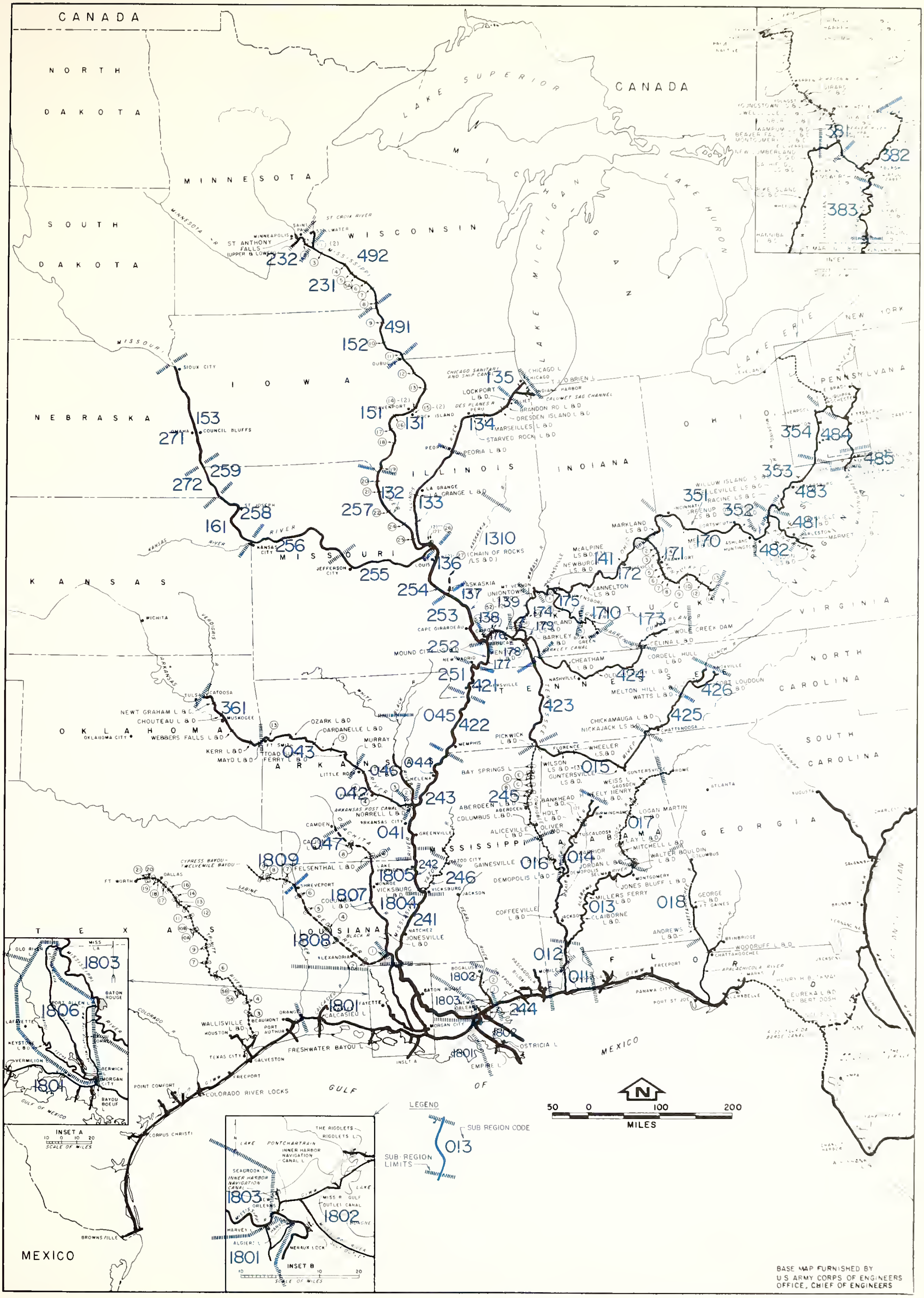
Step 2: Political Boundaries

Indiana
Ohio
Kentucky
West Virginia
Illinois
Indiana
KENTUCKY
Kentucky
Tennessee

Step 3: Combine and Assign Subregional Codes

172
170
171
172
175
176
KENTUCKY
1710
179
173
177
178

FIGURE 2 DEVELOPMENT OF SUBREGIONS


CANADA
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
WISCONSIN
IOWA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
NEW YORK
KENTUCKY
VIRGINIA
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
ALABAMA
MISSISSIPPI
ARKANSAS
LOUISIANA
FLORIDA
MEXICO
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
GULF OF MEXICO
MISSOURI RIVER
232
231
492
491
152
151
131
135
134
132
133
1310
136
137
138
139
271
153
259
272
258
161
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012
011
244
1809
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1804
1808
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1803
1802
1801
INSET A
INSET B
LEGEND
SUB REGION CODE
SUB-REGION LIMITS
013
50 0 100 200
MILES
N

BASE MAP FURNISHED BY U.S. ARMY CORPS OF ENGINEERS OFFICE, CHIEF OF ENGINEERS

FIGURE 3 STUDY SUBREGIONS

The final step in subregion preparation was the definition of subregional boundaries shown in Figure 3. A summary table in Appendix E defines the 89 subregions by river mile. The 1975 waterborne tonnage sent and received by each subregion is summarized in Appendix F.

GENERAL OBSERVATIONS

The large number of waterways, state boundaries and thousands of terminal facilities and channels that had to be considered precluded the use of automated processing of channel information in the development of subregions. The analysis undertaken has resulted in an accurate final product and a logical structure for utilizing, on an on-going basis, Army Corps WCSC Waterborne Commerce data. In this regard, consideration was given to possible future analysis by Federal, state, local and commercial interests at different levels of detail: channel, port or port equivalent; altered port; river reach; river, subregion; or state on the basis of origin and destination.

In the course of performing this task, a number of areas that impose limitations on the validity of selected river, state and river systems were revealed. These weaknesses are not caused by analytical limitations, but rather by the structure and maintenance of the basic WCSC data. Areas of current limitation include:

> A range in the level of detail of selected Army Corps of Engineers channels that precludes meaningful analysis at levels consistent with the majority of channels. An example is the current assignment of one channel, 15094 to more than 250 miles of the Appalochicola, Chattahoochee and Flint Rivers in three states, Alabama, Florida and Georgia.

- Certain recurring errors in the compilation of commodity movements by towboat captains. An example occurs at mile 927 on the Ohio River, a site where tows leaving the Tennessee River and destined for upriver points on the Ohio are often grounded on the north bank of the Ohio. This "delivery" is sometimes reported by towboat captains, and is compiled and represents more than 1.2 million tons of incorrect activity in 1975.

- Certain operational carelessness by towboat captains. An example occurs on the Big Sandy River which adjoins the Ohio River. Twenty barge, Ohio River tows must be handled in tows of four barges on the Big Sandy River. Big Sandy River towboats consistently fail to record their hauls and thus the Ohio River River fleet area becomes the barges' origin and destination. This is known to understate Big Sandy River traffic by more than 1 million tons annually.

- Variation in the assignment of selected commodities. An example is the hundreds of channels that receive and the few that send materials destined for waterway improvement and maintenance. A waterside terminal loads bulkhead steel sheet piling on a barge and lists that cargo as a primary ferrous product -- Commodity Group 12, yet it is generally offloaded at an undeveloped riverbank for use as waterways improvement material -- Group 20. Sand and gravel (for dikes), certain mining products, and lumber (for pile dikes) are also liable to this conflict in definition. A separate annual listing of authorized waterway improvement sites and mid-stream dredging permit locations for both channel maintenance and commercial sand and gravel uses would constitute a major step towards definitive clarification of this segment of river operations.

Although these limitations are present, they do not detract from the overall quality of the analysis. Non-terminal shipments and receipts of material constitute less than 1 percent of all waterway tonnage, and the 2,000 channels that form the ports of Mid-America region handle nearly the entire universe of commodity shipments and receipts that move through waterside terminals.

CHAPTER 3

CURRENT ECONOMICS AND DEMOGRAPHICS OF STUDY AREA

Economic and demographic analyses and forecasts should reflect the transportation needs of the study region. Ideally, this entails a forecast of production, intermediate demand, and final demand for each of the 20 commodity groups in each of the 89 subregions -- nearly 6,000 forecasts. Available economic data, however, are not sufficient for such an exhaustive econometric analysis. Consequently, a review was made of available data in light of the requirements of the study, the resources provided, and the data constraints imposed by disciplined economic analysis to determine which forecasts would be most appropriate for this Study.

ECONOMIC OVERVIEW

The bulk of river traffic is made up of coal, grains, and manufactured goods. Reasonably accurate, detailed time-series data for these commodities are available at the state level, so that the state (or region, in the nomenclature of this study) became the primary unit of economic analysis. At the state level, manufactured goods data are available at the two-digit SIC code level. Industry data available for one or more of the study regions were as follows:

SIC Code	Description
20	foods
21	tobacco and products
22	textile mill products
23	apparel products
24	lumber and products
25	furniture and fixtures
26	paper and products

SIC Code	Description
27	printing and publishing
28	chemicals and products
29	petroleum and coal products
30	rubber and plastic products
31	leather and products
32	clay, glass, stone products
33	primary metals
34	fabricated metal products
35	non-electrical machinery
36	electrical machinery
37	transportation equipment
38	instruments and related products

State-level, long- and short-term forecasts for these industries are already included in Chase Econometric Associates, Inc.'s (CEAI's) Regional Forecasting Network, and no substantial development efforts were required prior to the actual generation of forecasts for these industries. A principal strength of the Regional Forecasting Network for generating the forecasts of manufacturing activity for this study is that, unlike most work in multiregional forecasting, it is not predicated on the simple allocation of manufacturing activities to the various regions by some factors of fixed proportionality. Clearly some regions respond differently to boom and recession and others have experienced long-term growth or decline in their share of national production. Table 3-1 illustrates the importance of this fact for this study.

During the period from 1970 to 1977 total shipments of manufactured goods in the study region increased at an annual rate of 2.6 percent versus the 2.4 percent growth in the nation as a whole. However, growth rate in individual states during the same period varied from a high of almost 9 percent in Louisiana to a low of less than 1 percent in Pennsylvania. A portion of that variation is, of course, due to differing industrial mixes among states, as Table 3-2 illustrates. However, even at the single-industry level, a similar variation would be evident.

TABLE 3-1

STATE PRODUCTION CHARACTERISTICS

State	1977 Shipments of Manufactured Goods, 1967$ (billions)	% of U.S.	Growth Rate 1970-1977(%)
Alabama	10.3	1.5	3.40
Arkansas	6.1	0.9	4.08
Illinois	47.1	6.9	1.49
Indiana	26.2	3.8	2.59
Iowa	11.8	1.7	3.73
Kansas	8.5	1.2	7.30
Kentucky	11.5	1.7	4.02
Louisiana	14.4	2.1	8.71
Minnesota	11.7	1.7	2.29
Mississippi	6.2	0.9	5.12
Missouri	16.1	2.4	1.49
Nebraska	5.1	0.7	3.57
North Dakota	0.7	0.1	6.20
Ohio	48.8	7.1	1.86
Oklahoma	5.9	0.9	6.20
Pennsylvania	41.3	6.0	0.60
South Dakota	0.9	0.1	3.40
Tennessee	14.3	2.1	2.81
W. Virginia	4.5	0.7	1.41
Wisconsin	20.9	3.1	4.04
Region	312.3	45.7	2.6
U.S.	683.9		2.4

Source: Annual Survey of Manufactures

TABLE 3-2

HISTORICAL INDUSTRIAL GROWTH RATES

State	Principal Industries (1969-1976 compound growth rate in value added)
Alabama	primary metals (0.1%) textile mill products (7.5%) chemicals & products (-2.7%)
Arkansas	foods (5.2%) electrical machinery (5.7%) chemicals & products (16.6%)
Illinois	non-electrical machinery (2.6%) electrical machinery (-0.8%) foods (3.0%) chemicals & products (6.1%)
Indiana	chemicals & products (4.1%) primary metals (-0.6%) fabricated metals (2.1%) foods (3.4%)
Iowa	non-electrical machinery (8.5%) foods (5.5%)
Kansas	transportation equipment (1.8%) foods (9.1%) chemicals & products (2.7%)
Kentucky	electrical machinery (0.7%) non-electrical machinery (6.0%) chemicals & products (5.1%)
Louisiana	chemicals & products (15.1%)
Minnesota	non-electrical machinery (3.2%) foods (3.9%)
Mississippi	transportation equipment (23.0%) apparel products (11.1%) chemicals & products (10.4%)
Missouri	transportation equipment (9.4%) chemicals & products (6.9%) foods (3.8%)
Nebraska	foods (5.4%)
Ohio	transportation equipment (3.9%) non-electrical machinery (0.7%) electrical machinery (-1.7%) fabricated metals (1.5%) primary metals (-2.0%) chemicals & products (2.7%) rubber & plastic products (2.3%) foods (3.8%)
Oklahoma	non-electrical machinery (11.1%) petroleum & coal products (14.9%)
Pennsylvania	primary metals (-0.5%) electrical machinery (-1.4%) non-electrical machinery (1.5%)
Pennsylvania	chemicals & products (1.7%) foods (2.8%) transportation equipment (1.1%) fabricated metals (0.1%) apparel products (2.1%)
Tennessee	chemicals & products (2.5%) apparel products (11.1%) electrical machinery (1.2%) foods (6.1%)
West Virginia	chemicals & products (1.5%)
Wisconsin	non-electrical machinery (3.2%) foods (5.3%) transportation equipment (9.9%) electrical machinery (3.9%)

Source: Annual Survey of Manufactures

The chemicals industry in Pennsylvania and Louisiana is currently of comparable size. However, the chemicals industry (SIC 28) in Pennsylvania experienced an annual growth of 1.7 percent; in Louisiana, during the same period, the industry experienced growth in excess of 15 percent per year.

Such differences between regions reflect the difference in the cost of doing business between regions. Producers in the Northeastern and Middle Atlantic states, such as Pennsylvania, generally suffer higher labor and tax costs, and bear a relatively higher tax load than do producers in the Western and "Sun Belt" states such as Louisiana. The secular effect on a region of lower relative business costs is to enhance its attractiveness to investment, and hence also to increase its share of future national production: higher investment levels mean a larger capital stock, and, in turn, increased output and relatively greater demand for waterborne transportation. Such considerations do not materially affect short-term forecasts of regional economic activity; in long-term forecasting of the type required by this study, however, they are of paramount importance. To ignore them would have entailed the risk of seriously misstating the location of transportation demand within the study area, even if the aggregate forecast for the region is correct.

The concept of relative regional profitability is incorporated in the Regional Forecasting Network, however, through measures such as relative unit labor costs, relative industrial electricity and natural gas costs, and relative tax load. In this way, the network facilitates a more dynamic linkage of regional manufacturing activity to national and international influences.

DEMOGRAPHIC OVERVIEW

The same factors which influence a region's relative profitability for business enterprises also go a long way towards explaining regional demographic trends. Tables listing trends in employment and income by industry would reflect the same rates of relative growth and decline which characterized Tables 3-1 and 3-2. Table 3-3 summarizes the most general impact of these factors: on the states' total resident population.

Most of the nation's fastest growing states lie outside the study region--to the West. Only Oklahoma's population growth can be considered high when ranked against the nation as a whole. A fair number of the nation's slowest growing states, however, do lie within the study region. Pennsylvania lies near the bottom of the list. Mississippi, Kansas, West Virginia and South Dakota have been slow-growth states, although their relative position should improve in the next decade, due largely to an improving economic picture for these states. In general, as one moves south and west through the study region, one encounters higher population growth due to a relatively bright economic outlook and the development of energy resources. The continuing trend to move "West," combined with a lower birth rate, accounts for the change in the Northeast from slow positive growth to a stagnant or declining position. The increasing cost of energy accelerates this trend as harsher climates become more expensive as well as relatively unpleasant.

COAL & CASH GRAINS

Two of the twenty commodity groups--cash grains and coal--together account for over 40 percent of current waterborne tonnage. Coal tonnage alone accounts for about 30 percent of total tonnage, and has been characterized by relatively stable, slow growth (about 3 percent during the 1969-1976 period). Cash grains movements, on the other hand, have been characterized by rapid, erratic growth. At an annual compound growth rate of over 10 percent, the cash grains are the most rapidly growing commodity group; in 1972, however, waterborne shipments jumped 30 percent over the year previous. The sheer volume of coal, coupled with the rapid growth and high variability of cash grains, make these forecasts key to the integrity of the whole study. For this reason, both groups

TABLE 3-3

POPULATION OF STUDY REGION STATES
(Percent of Total U.S.)

State	Existing 1976	Existing 1977	Projected 1987
Alabama	1.76%	1.71%	1.69%
Arkansas	.99	.99	1.02
Illinois	5.48	5.20	4.92
Indiana	2.53	2.46	2.30
Iowa	1.39	1.33	1.31
Kansas	1.15	1.08	1.11
Kentucky	1.61	1.60	1.59
Louisiana	1.86	1.81	1.85
Minnesota	1.83	1.84	1.84
Mississippi	1.18	1.10	1.10
Missouri	2.31	2.22	2.14
Nebraska	0.73	0.72	0.72
North Dakota	0.31	0.30	0.30
Ohio	5.31	4.95	4.67
Oklahoma	1.27	1.30	1.40
Pennsylvania	5.88	5.45	5.05
South Dakota	0.33	0.32	0.33
Tennessee	1.98	1.99	2.09
West Virginia	0.91	0.86	0.88
Totals	38.81%	37.21%	36.31%
U.S. Population			
(millions)	197.5	216.3	231.5
(10-year growth rate)	1.50%	0.90%	0.68%

were the object of particularly careful examination.

Coal Production and Consumption

Until the 70's, virtually all the coal produced domestically was supplied by the states in the study region, principally Kentucky, Pennsylvania, West Virginia, Illinois, and Ohio. The study region's share of total domestic coal production during the 70's has fallen from 96 percent to about 80 percent at present. This shift reflects the rather rapid development of coal reserves in the western states--particularly the Northern Great Plains. Currently, low sulphur-content coal from the Northern Great Plains is being shipped to Appalachia, the Ohio River Valley, the western Great Lakes, the Midwest, the Southeast, and the south central states to coal-burning operations seeking to reduce their emissions to meet local and Federal air-quality standards. Major contracts ranging from 10 to 25 years have been made to ship coal to Texas, Arkansas, Illinois, Minnesota, Indiana, and Michigan. Further, major electric generating facilities are being planned in this area, from which large amounts of electrical energy will be exported to states in the study region.

Production of coal--both in and outside the study region--has typically been demand-limited. The primary users of coal are the electric power utilities, which currently account for over 75 percent of total domestic consumption, with the balance primarily accounted for by coke plants, steel and rolling mills, and other industrial users. Within the study region, however, there are substantial variations from this pattern. Electric utilities in Missouri, for example, account for about 90 percent of the state's total coal consumption; in Pennsylvania, however, the utilities account for only half the state's consumption, with the state's steel industry accounting for most of the balance. Such end-use differences from one state to another go a long way towards explaining wide variation in growth rates for coal consumption among the states comprising the study area. Though coal consumption has increased throughout the area, it has recently ranged from less than 2 percent annually in Ohio and Pennsylvania to over 16 percent annually in Kansas/Nebraska, as Table 3-4 illustrates. Recent trends in the coal producing states of the study area are even more divergent. As Table 3-5 illustrates, there are rapid shifts occurring in the geographic location of coal production. Though Kentucky and West Virginia are both major producers, West Virginia's production has dropped at an annual average rate of 3.6 percent a year; during the same time, Kentucky's production has increased 3.6 percent annually.

Such variations in coal production and consumption within the study region--in light of the importance of coal movements to the inland waterways--necessitated development of a regional coal production and consumption model for the study area. Production equations were estimated for each of the ten producing states listed in Table 3-5; consumption equations were estimated for the thirteen regions listed in Table 3-4. The equations are described in Appendix D.

Cash Grains

Similar efforts were undertaken for the cash grains commodity group. The Mid-America waterways system services a large portion of America's breadbasket. Within easy reach of the system is almost 75 percent of the nation's grain and soybeans. The system currently carries about three-fifths the wheat and soybeans and about half the corn moved by barge in the U.S. Growth in agricultural production within this area during the current decade has been phenomenal. Prior to 1972, the agricultural sector of the states bordering the Mississippi River had suffered from excess U.S. grain inventories forcing reduced crop acreages. In 1972, however, world grain and

TABLE 3-4

COAL CONSUMPTION
(millions of short tons)

Region	1976 Consumption*	1969-1976 Growth Rate
Alabama/Mississippi	39.5	6.4%
Illinois	54.3	2.6%
Indiana	51.2	3.1%
Iowa	6.9	2.8%
Kansas/Nebraska	4.2	16.2%
Kentucky	36.8	8.8%
Minnesota	12.1	5.9%
Missouri	17.1	6.3%
Ohio	68.4	1.4%
Pennsylvania	68.3	1.9%
Tennessee	29.9	8.6%
West Virginia	37.3	6.3%
Wisconsin	20.0	4.2%
Total	456.0	4.4%
U.S.	598.8	2.4%

Source: Department of Energy
(Formerly reported by Bureau of Mines)

* Based on shipments to end users within each state; does not include transshipments or inventories held at point of use. Consumption less than 100,000 tons not reported for states of Arkansas, Louisiana and Oklahoma.

TABLE 3-5

COAL PRODUCTION
(millions of short tons)

Region	1976 Production	1969-1976 Growth Rate
Alabama	21.6	3.1%
Illinois	58.0	-1.6%
Indiana	24.1	2.7%
Kentucky	140.0	3.6%
Missouri	5.4	7.3%
Ohio	45.5	-1.7%
Oklahoma	3.3	8.7%
Pennsylvania	83.7	0.9%
Tennessee	8.8	1.1%
West Virginia	108.9	-3.6%
Total	499.3	0.1%
U.S.	684.9	2.6%

Source: Department of Energy
(Formerly reported by Bureau of Mines)

soybean production failures caused grain shortages in Europe, Russia, and Southeast Asia. In 1971 only 21 percent of crop acreage in states adjacent to the Mississippi was harvested for export; by 1974, however, exports had risen to 43 percent of harvested acreage. During the same period, total crop acreage harvested in the area rose by 10 percent. Currently, the states bordering the Mississippi River system are the world's largest single source of agricultural exports.

Major geographical changes in domestic demand for grains and soybeans are also having a pronounced impact on grain shipments on the inland waterways. Over the past decade southeastern states have become major producers of poultry, beef, and other livestock. These states, bordering the lower Mississippi, have thus become major grain deficit areas, and rely on low-cost barge transportation from the Midwest to remain competitive with major east coast and southwest states in poultry and livestock production.

Three crops produced in the study area account for 98 percent of all tonnage of the cash grains commodity group on the inland waterways-- wheat, corn, and soybeans. Production of these crops (i.e., crop acreages and yields) is well reported at the state-level by the USDA. All states in the study area are producers (see Table 3-6), although three states-- Illinois, Iowa, and Indiana--account for nearly half the region's total production, and well over a third of the nation's production of these crops (in terms of volume). CEAI utilized its U.S. Agriculture and Regional Agriculture databases to develop econometric equations for acreage harvested and yield per acre for each crop in each state. (Crop production is an identity: harvested acres times yield per acre.) The resulting model related each state's production to both national factors (such as crop prices and government policy) and local factors (competing crops and climate) as a foundation for the task of forecasting cash grains production to the year 2000.

TABLE 3-6

1977 GRAIN PRODUCTION*
(millions of short tons)

State	1977 Production	1970-1977 Annual Compound Growth
Alabama	1.59	8.5%
Arkansas	3.88	2.5%
Illinois	44.43	6.8%
Indiana	22.83	6.8%
Iowa	42.28	5.1%
Kansas	16.81	5.3%
Kentucky	4.92	14.4%
Louisiana	2.07	5.9%
Minnesota	18.90	4.6%
Mississippi	3.03	5.9%
Missouri	10.88	3.9%
Nebraska	20.40	6.0%
North Dakota	7.65	6.4%
Ohio	15.32	6.3%
Oklahoma	5.10	6.5%
Pennsylvania	3.20	3.1%
South Dakota	4.37	0.9%
Tennessee	3.30	9.8%
West Virginia	0.14	3.5%
Wisconsin	5.96	4.4%
Total	237.07	5.7%
U.S.	290.27	6.2%

Source: Department of Agriculture

* Wheat, corn and soybeans

CHAPTER 4

HISTORICAL COMMODITY MOVEMENTS

Statistics on inland waterway cargo movements are collected and maintained by the U.S. Army Corps of Engineers. Cargoes are classified by the Corps into one of 172 Commodity Classifications for Shipping Statistics (CCSS), which in turn comprise 41 commodity groups. These commodity groups parallel the Standard Industrial Classification (SIC) coding system. Many of the 41 resultant commodity groups represent small fractions of the total tonnage moved on the inland waterways.

To meet the requirements of the Mid-America Ports Study, the 171 commodities were regrouped into 20 commodity groups. This classification resulted in a smaller, more manageable number of groups, each of which exhibits roughly similar cargo handling requirements and relationships to econometric factors. The 20 commodity groups are used consistently throughout the study in both historical and forecast time periods.

CLASSIFICATION METHODOLOGY

Figure 4 outlines the procedure used in defining commodity groups. The primary objective was to limit the forecasting process by meaningful groups which would be large enough in volume to be significant, yet internally consistent in handling characteristics.

To achieve this objective, consideration was given to each commodity's cargo handling characteristics and that commodity's relationship to a specific industry or other economic variable. The commonality of cargo handling characteristics within a group enables that group to be matched with a specific type of cargo handling terminal.

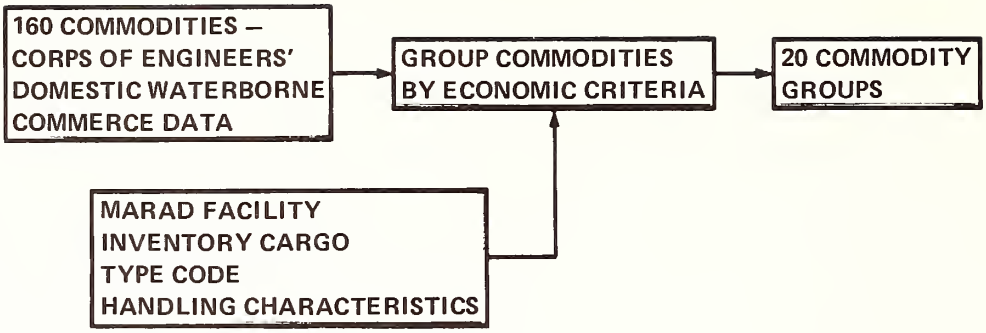
160 COMMODITIES – CORPS OF ENGINEERS' DOMESTIC WATERBORNE COMMERCE DATA
GROUP COMMODITIES BY ECONOMIC CRITERIA
20 COMMODITY GROUPS
MARAD FACILITY INVENTORY CARGO TYPE CODE HANDLING CHARACTERISTICS

FIGURE 4 - DEFINITION OF COMMODITY GROUPS

The second criterion associated a commodity with a specific industry, usually its major consumer or producer; an economic variable was used to facilitate the forecasting process.

The two criteria used in formulating the groups did not always compliment each other. In some cases certain tradeoffs had to be made between a commodity's fit with the group in physical handling aspects and from the viewpoint of its relationship to the primary economic variable that would be used to forecast the entire group.

Salt (CCSS 1491) is an example of such a tradeoff between handling characteristics and forecasting considerations. Without considering handling characteristics, salt would have been grouped with the Industrial Chemicals Group, reflecting the commonality of their principal users. However, the other commodities in the industrial chemicals group are primarily moved in liquid form, whereas salt is moved in dry bulk form and has substantially different handling requirements. As a result, salt was grouped with Mining Products, where its production and movements can be forecast using growth in the mining sector as an independent variable.

Certain commodities moved on the inland waterways of the study area in small volumes or not at all. Even though this effect on the overall study would be small, every effort was made to avoid miscellaneous groupings that would be internally inconsistent when considering that group's handling requirements and forecasting variables. Table 4-1 identifies the 20 Mid-America Ports Study Commodity Groups, each of which is treated in detail in Appendix A.

DESCRIPTION OF HISTORICAL COMMODITY MOVEMENT DATA

Figure 5 shows the total domestic inland waterways commodity movements that were shipped and received by the 17 states participating in this study, including shipments that originated from or were destined to states outside the study area.

The tonnage volumes shown in Figure 5 are composed of three components: inbound cargo volumes from out of state, outbound cargo volumes to out of state, and intrastate cargo volumes. Intrastate outbound flows (from a subregion) are equal to intrastate inbound flows (to a subregion). In this presentation intrastate flows are recorded only once, which represents the intrastate volume on the states' waterways; however, by doubling the intrastate volume represented in the totals shown herein, the total intrastate flows requiring handling by the terminal facilities is obtained.

The accuracy of historical commodity movement data developed in this study has been verified against summary Army Corps of Engineers statistics. These historical flows served as the basis for all subsequent forecasting procedures.

OVERVIEW OF HISTORICAL COMMODITY MOVEMENTS

The study area's waterborne commerce experienced a 1.3 percent average annual growth rate in the 1969-1976 period. Interstate traffic expanded at a 1.6 percent rate while intrastate

TABLE 4-1

MID-AMERICA COMMODITY GROUPS

Commodity Group Code	Commodity Group Description
1	Cash Grains
2	Iron and Non-ferrous Metal Ores and Concentrates
3	Bauxite and Aluminum Ores
4	Coal and Coal Products
5	Crude Petroleum
6	Petroleum Products and Lubricants
7	Industrial Chemicals
8	Agricultural Chemicals/Fertilizers
9	Milled Grain and Agricultural Products, NEC
10	Lumber and Wood Products
11	Sugar and Molasses
12	Primary Ferrous and Nonferrous Metal Products
13	Fabricated Metal Products
14	Scrap Metals
15	Construction Materials
16	Mining Products, NEC
17	Non-durable Manufactures NEC, including Processed Foods
18	Durable Manufactures, NEC
19	Waste and Scrap Materials, Miscellaneous
20	Waterway Improvement and Government Materials

traffic grew at only .7 percent. This performance compares to a 1.3 percent compound growth of manufacturing shipments within the Mid-America Region and a 2.4 percent compound growth in real U.S. GNP.

The most rapidly growing commodity groups in the period 1969-1976 included: cash grains with a 9.7 percent compound annual growth attributable, largely, to increased U.S. export activity, including the Russian Grain Deal; agricultural chemicals with an 8.7 percent annual growth, whose expansion was related to increasing land utilization in the U.S. and abroad; milled grain with a 16.4 percent growth, due to export activity; petroleum production with a 4.0 percent annual growth, as U.S. demand outstripped increases in regional production and imported crude oil was refined along the Lower Mississippi for upstream distribution. The introduction of local electric furnaces to the south and export activity stimulated increased scrap metal movements.

Traffic that grew less rapidly than overall traffic included: crude petroleum which declined to half its 1969 volume by 1976 due to the rationalization of refinery logistics, pipeline construction and imports; iron and non-ferrous ores which remained relatively stable; bauxite and aluminum which fluctuated widely due to U.S. demand and plant capacity; and construction materials and mining products which remained relatively stable.

Two commodity groups (coal and petroleum products) constitute approximately 50 percent of waterborne traffic in the Mid-America Region. Including an additional three (cash grains, construction materials, crude petroleum) brings this figure to 75 percent. Four more commodity groups (industrial chemicals, mining products, agricultural chemicals/fertilizers, iron and non-ferrous ores) each comprise more than two percent of the traffic. The remaining eleven commodity groups amount to less than 9 percent of waterborne trade in the Mid-America Ports Study.

Table 4-2 presents a tabulation of major characteristics and relationships of all 20 Mid-America Ports Study commodity groups. The significant participation of Louisiana in all flows except coal and construction materials is notable. This fact emphasizes the role of the Mississippi River network as an extension of international commerce and a principal artery of the nation. The respective importance of Kentucky, Louisiana, and Illinois in coal, petroleum products and cash grain shipments attest to the geographical and industrial scope of the Mid-America Region.*

The historical pattern of waterborne commodity flows within the study area is also of interest. This pattern is shown for the largest volume movements in Figures 6A, 6B, 6C and 6D, which summarize the 1976 state-to-state origin-destinations of grains, coal, crude oil and petroleum products, respectively. Grains (Figure 6A), in comparison to other commodities, are long-haul movements originating in the northern study states with destinations in Louisiana and Alabama. Coal (Figure 6B) is predominantly short-haul, with significant volumes moving intrastate. Crude Oil (Figure 6C) waterborne shipments originate in Louisiana and Alabama and have destinations in the northern study states. Petroleum Products (Figure 6D) movements consist of both long-haul shipments, with originations in Louisiana, and short-haul, intrastate shipments.

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* Historical commodity flows for each of the study's subregions are presented by state in Appendix G.

TABLE 4-2

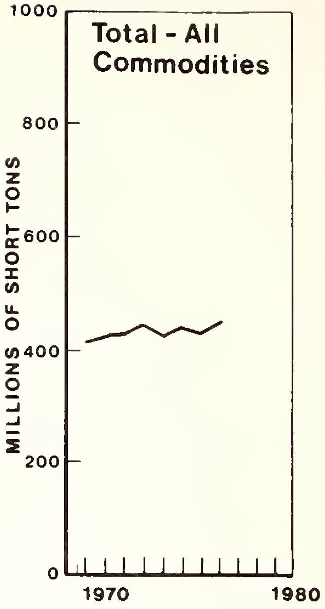
COMPARISON OF COMMODITY GROUPS MOVING WITHIN MID-AMERICA

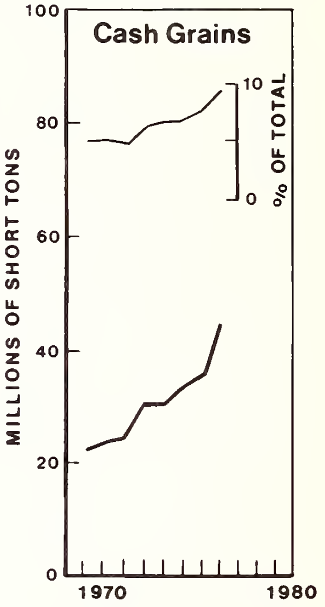
(thousands of tons)

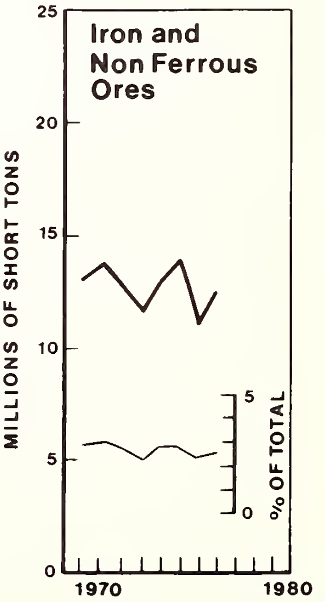
	Commodity Group	1976 Tons	Percent of Total		Percent Interstate		Leading States Comprising 50% or More Unless Noted Arranged in Decreasing Volume		
			1969	1976	1969	1976	Inbound	Outbound	Intrastate
04	Coal and Coal Products	131,359	27.5	29.7	55.5	57.3	Ohio, Penn, Tenn	Ky, W.Va, Ill	Pa, Ala, W.Va.
06	Petroleum Products and Lubricants	87,452	16.3	19.7	85.7	81.6	La, Tenn, Ky	La, Miss, Ill	La, Ill, Minn
01	Cash Grains	44,318	5.7	10.0	96.5	95.6	La, Ala, Tenn	Ill, Minn, Mo	La, Ala, Ill
15	Construction Materials	42,741	11.2	9.6	39.9	44.9	W.Va, Ill, Tenn	Ind, Ky, Oh	Ill, Miss, Ark
05	Crude Petroleum	33,811	16.8	7.6	63.4	45.3	La, Tenn, Miss,	La, Ala, Miss	La, Ala, Ill
07	Industrial Chemicals	25,673	5.8	5.7	70.0	74.2	Ill, La, Ala,	La, Ill, W.Va	La, W.Va, Penn
16	Mining Products	15,711	4.2	3.5	49.7	45.9	Ill, Ala, Ky	La, Ala, Ill	La, Ala, Ill
08	Agricultural Chemicals/Fertilizers	13,175	1.8	2.9	93.8	98.1	La, Ill, Iowa	La, Miss, Ark	La, Miss, Mo
02	Iron & Nonferrous Ores	12,363	3.2	2.7	84.6	67.5	Ill, Oh, Penn	La, Penn, Oh	Ala, Ky, Il
09	Milled Grains & Agri. Prod, NEC	7,384	0.6	1.6	81.9	88.8	La, Ala, Tenn	Ill, Mo, Tenn	La, Miss, Ala
20	Waterways Improvement Materials	7,337	1.8	1.6	70.3	63.3	La, Miss, Tenn	Ky, Mo, Miss	La, Mo, Ark
12	Primary Metals	6,339	1.6	1.4	74.5	90.1	Ill, Tenn, La	La, Pa, Ill	La, Ill, Pa
19	Waste & Scrap Materials, Misc.	5,308	0.9	1.1	16.0	11.9	La, Mo, Ky	La, Ill, Wis	La, Il, W.Va
18	Durable Manufactures	2,842	0.4	0.6	25.5	27.9	Ala, La, Ky	La, Tenn, Miss	La, Ala, Miss
17	Non-Durable Manufactures	2,214	0.3	0.4	85.7	73.6	La, Oh, Tenn	La, Miss, Ark	La, Ala, Ill
10	Lumber & Wood Products	1,797	0.4	0.4	32.4	51.5	Miss, Tenn, La	Ala, La, Tenn	Ala, Miss, Tenn
14	Scrap Metals	1,558	0.1	0.3	84.0	89.2	Pa, Ill, La	Ala, Tenn, Ill	Ill, La, Ala
11	Sugar and Molasses	1,240	0.3	0.2	94.6	90.3	Ill, Io, Mo	La, Minn, Ala	La, Ill, Ala
13	Fabricated Metals	535	0.1	0.1	83.1	62.6	W.Va, La, Ill	La, Penn, Ill	La, Pa, Ill
03	Aluminum and Bauxite	420	0.1	0.0	100.0	100.0	Ark, Ohio, Ill	La, Ala	No Movement
	Total	443,585	100.0	100.0	-	-			

Source: Waterborne Commodity Statistics, U.S. Army Corps of Engineers
Analysis of statistics by TBS.

COMMODITY		FROM OUT OF STATE	FROM IN STATE	TOTAL	% INBND FROM OUT OF STATE	% GROWTH FROM PREV YEAR	ANNUAL % OF ALL CMDTYS INBND
TOTAL ALL COMMODITIES							
	1969	263995825	140762802	404758627	65.2	.0	100.0
	1970	276351681	145077147	421428828	65.5	4.1	100.0
	1971	283929951	145050459	428980410	66.1	1.7	100.0
	1972	291171124	151459233	442630357	65.7	3.1	100.0
	1973	273722561	152842340	426564901	64.1	-3.6	100.0
	1974	279905918	154634623	434540541	64.4	1.8	100.0
	1975	281560375	148442942	430003317	65.4	-1.0	100.0
	1976	295458726	148135712	443594438	66.6	3.1	100.0
CASH GRAINS 01							
	1969	22428974	803790	23232764	96.5	.0	5.7
	1970	23351699	769448	24121147	96.8	3.8	5.7
	1971	23314229	991668	24305897	95.9	.7	5.6
	1972	29749063	1051635	30800698	96.5	26.7	6.9
	1973	29852331	892862	30745193	97.0	-.1	7.2
	1974	31570681	1465359	33036240	95.5	7.4	7.6
	1975	35309065	1379737	36688802	96.2	11.0	8.5
	1976	42380385	1937664	44318049	95.6	20.7	9.9
IRON+NONFERROUS ORES 02							
	1969	11052142	2005085	13057227	84.6	.0	3.2
	1970	11699564	1923596	13623160	85.8	4.3	3.2
	1971	10045413	2482423	12527836	80.1	-8.0	2.9
	1972	8814847	2908197	11723044	75.1	-6.4	2.6
	1973	9753894	3169535	12923429	75.4	10.2	3.0
	1974	9536276	4263911	13800187	69.1	6.7	3.1
	1975	8727292	2460918	11188210	78.0	-18.9	2.6
	1976	8345561	4017485	12363046	67.5	10.5	2.7



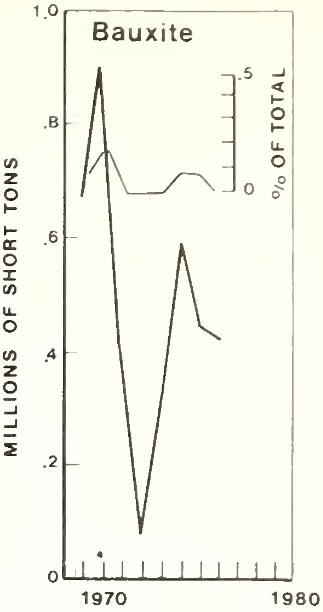


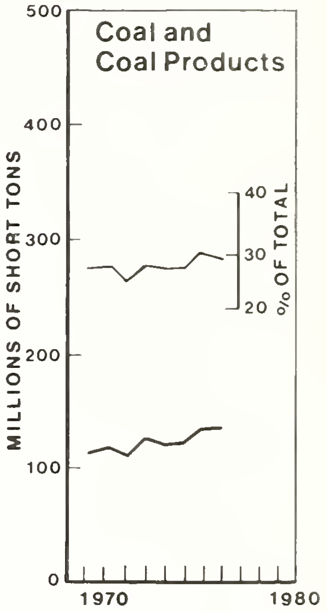


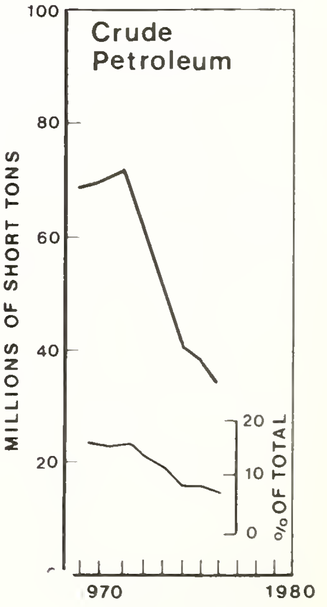
TABULATIONS BY TBS
GRAPHIC PRESENTATION BY TAMS

FIGURE 5
HISTORICAL WATERBORNE COMMODITY MOVEMENTS

COMMODITY		FROM OUT OF STATE	FROM IN STATE	TOTAL	% INBND FROM OUT OF STATE	% GROWTH FROM PREV YEAR	ANNUAL % OF ALL CMDTYS INBND
BAUXITE+ALUMINUM ORE 03							
	1969	668144		668144	100.0	.0	.1
	1970	905382		905382	100.0	35.5	.2
	1971	395489		395489	100.0	-56.3	.0
	1972	75288		75288	100.0	-80.9	.0
	1973	312348		312348	100.0	314.8	.0
	1974	582910		582910	100.0	86.6	.1
	1975	446209		446209	100.0	-23.4	.1
	1976	420344		420344	100.0	-5.7	.0
COAL+COAL PRODUCTS 04							
	1969	61881124	49528511	111409635	55.5	.0	27.5
	1970	65352768	51693668	117046436	55.8	5.0	27.7
	1971	64053116	47191749	111244865	57.5	-4.9	25.9
	1972	73124045	51077228	124201273	58.8	11.6	28.0
	1973	68833525	50394214	119227739	57.7	-4.0	27.9
	1974	70449089	51039979	121489068	57.9	1.8	27.9
	1975	75163546	55611468	130775014	57.4	7.6	30.4
	1976	75377525	55982360	131359885	57.3	.4	29.6
CRUDE PETROLEUM 05							
	1969	43218509	24899845	68118354	63.4	.0	16.8
	1970	43275636	26066738	69342374	62.4	1.7	16.4
	1971	44346677	27434135	71780812	61.7	3.5	16.7
	1972	34951288	27431995	62383283	56.0	-13.0	14.0
	1973	25961396	25966190	51927586	49.9	-16.7	12.1
	1974	20174117	20512000	40686117	49.5	-21.6	9.3
	1975	18640288	19800986	38441274	48.4	-5.5	8.9
	1976	15323378	18488179	33811557	45.3	-12.0	7.6



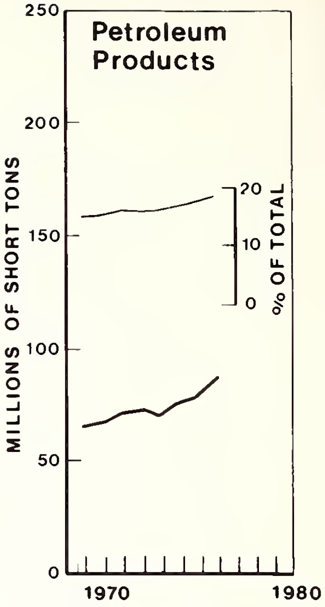




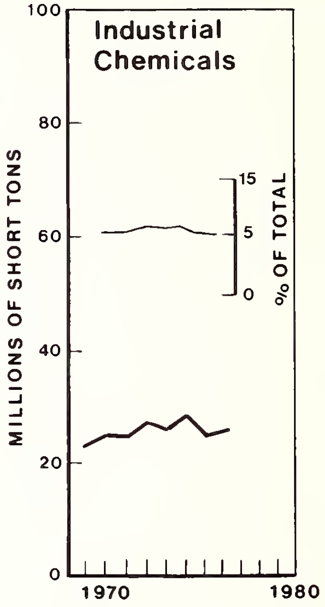
TABULATIONS BY TBS
GRAPHIC PRESENTATION BY TAMS

FIGURE 5
HISTORICAL WATERBORNE COMMODITY MOVEMENTS

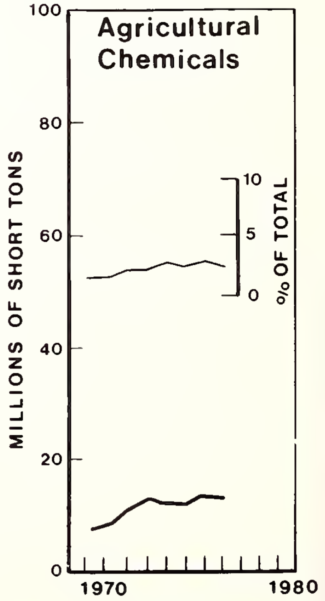
COMMODITY		FROM OUT OF STATE	FROM IN STATE	TOTAL	% INBND FROM OUT OF STATE	% GROWTH FROM PREV YEAR	ANNUAL % OF ALL CMDTYS INBND
PETRO PRODS+LUBRICAN	06						
	1969	56800310	9471858	66272168	85.7	.0	16.3
	1970	59432848	9302942	68735790	86.4	3.7	16.3
	1971	63350679	9830725	73181404	86.5	6.4	17.0
	1972	64838763	10003751	74842514	86.6	2.2	16.9
	1973	61745060	10988141	72733201	84.8	-2.8	17.0
	1974	64505499	12817564	77323063	83.4	6.3	17.7
	1975	67662741	12418869	80081610	84.4	3.5	18.6
	1976	71420612	16040686	87461298	81.6	9.2	19.7


Petroleum Products

COMMODITY		FROM OUT OF STATE	FROM IN STATE	TOTAL	% INBND FROM OUT OF STATE	% GROWTH FROM PREV YEAR	ANNUAL % OF ALL CMDTYS INBND
INDUSTRIAL CHEMICALS	07						
	1969	16601898	7086097	23687995	70.0	.0	5.8
	1970	17666660	7481079	25147739	70.2	6.1	5.9
	1971	18614505	7811168	26425673	70.4	5.0	6.1
	1972	19776121	8213602	27989723	70.6	5.9	6.3
	1973	18426069	8333960	26760029	68.8	-4.3	6.2
	1974	19915170	8826215	28741385	69.2	7.4	6.6
	1975	17376534	7651036	25027570	69.4	-12.9	5.8
	1976	19059602	6613861	25673463	74.2	2.5	5.7


Industrial Chemicals

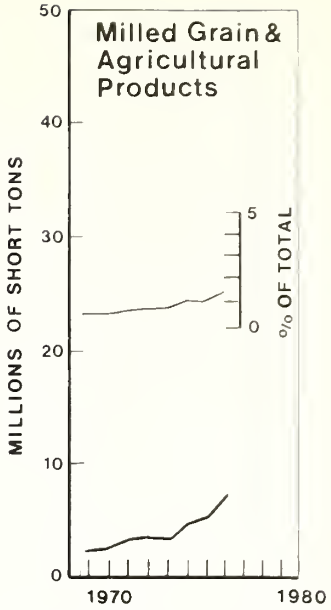
COMMODITY		FROM OUT OF STATE	FROM IN STATE	TOTAL	% INBND FROM OUT OF STATE	% GROWTH FROM PREV YEAR	ANNUAL % OF ALL CMDTYS INBND
AGRIC CHEMS+FERTZ	08						
	1969	6898578	453518	7352096	93.8	.0	1.8
	1970	8279995	551522	8831517	93.7	20.1	2.0
	1971	10290271	858276	11148547	92.3	26.2	2.5
	1972	11519502	1489192	13008694	88.5	16.6	2.9
	1973	11245834	1565077	12810911	87.7	-1.5	3.0
	1974	11075364	1601000	12676364	87.3	-1.0	2.9
	1975	12655373	879706	13535079	93.5	6.7	3.1
	1976	12937939	237700	13175639	98.1	-2.6	2.9

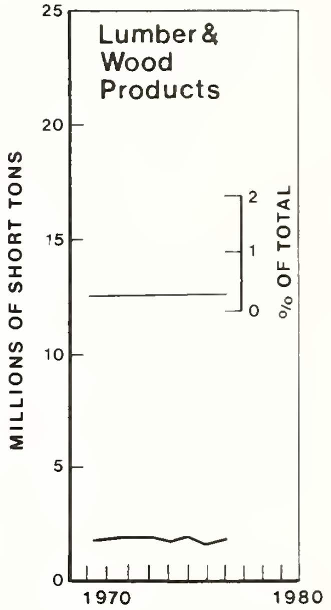

Agricultural Chemicals

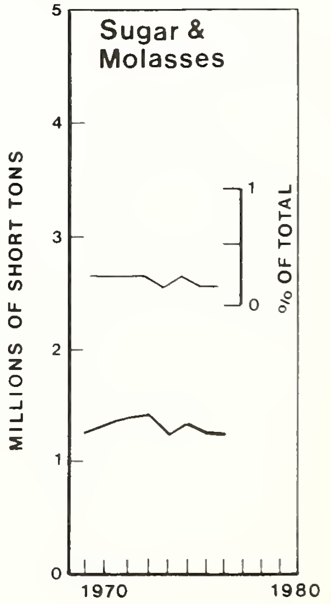
TABULATIONS BY TBS
GRAPHIC PRESENTATION BY TAMS

FIGURE 5
HISTORICAL WATERBORNE COMMODITY MOVEMENTS

COMMODITY		FROM OUT OF STATE	FROM IN STATE	TOTAL	% INBND FROM OUT OF STATE	% GROWTH FROM PREV YEAR	ANNUAL % OF ALL CMDTYS INBND
MILLED GRAIN+AG PROD	09						
	1969	2089328	459890	2549218	81.9	.0	.6
	1970	2415039	419287	2834326	85.2	11.1	.6
	1971	2715354	529874	3245228	83.6	14.4	.7
	1972	2961627	803405	3765032	78.6	16.0	.8
	1973	2939613	844772	3784385	77.6	.5	.8
	1974	4016489	889728	4906217	81.8	29.6	1.1
	1975	4622477	793762	5416239	85.3	10.3	1.2
	1976	6551375	820532	7371907	88.8	36.1	1.6
LUMBER+WOOD PROD	10						
	1969	625575	1302094	1927669	32.4	.0	.4
	1970	609443	1426396	2035839	29.9	5.6	.4
	1971	710150	1392929	2103079	33.7	3.3	.4
	1972	940646	1153925	2094571	44.9	-.4	.4
	1973	800922	1089769	1890691	42.3	-9.7	.4
	1974	1064095	987127	2051222	51.8	8.4	.4
	1975	941184	856021	1797205	52.3	-12.3	.4
	1976	933291	877300	1810591	51.5	.7	.4
SUGAR+MOLASSES	11						
	1969	1204118	67700	1271818	94.6	.0	.3
	1970	1207716	107410	1315126	91.8	3.4	.3
	1971	1316515	91263	1407778	93.5	7.0	.3
	1972	1302526	118462	1420988	91.6	.9	.3
	1973	1147601	115498	1263099	90.8	-11.1	.2
	1974	1242561	124154	1366715	90.9	8.2	.3
	1975	1063887	194182	1258069	84.5	-7.9	.2
	1976	1121067	119472	1240539	90.3	-1.3	.2



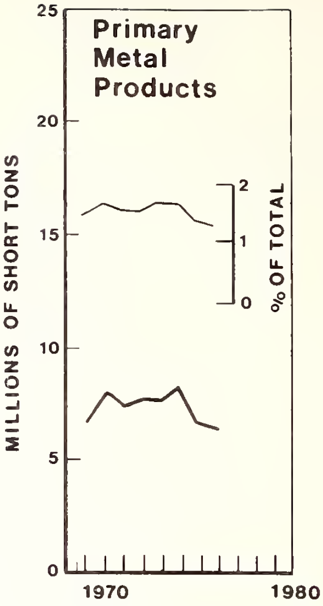


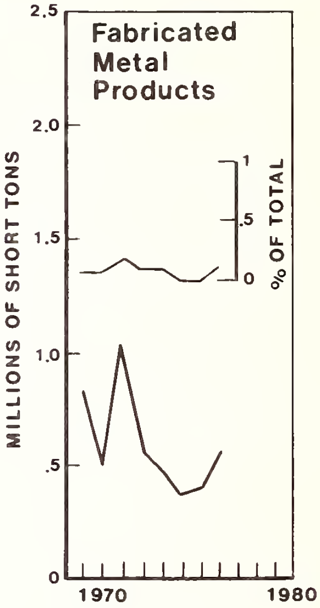


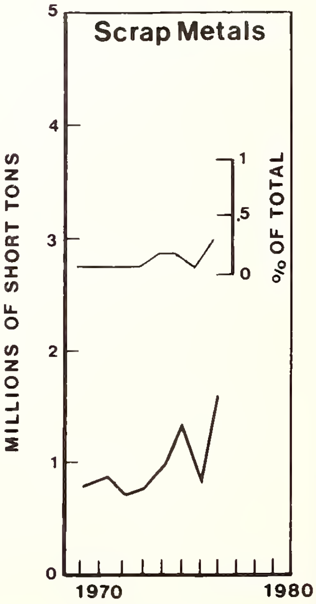
TABULATIONS BY TBS
GRAPHIC PRESENTATION BY TAMS

FIGURE 5
HISTORICAL WATERBORNE COMMODITY MOVEMENTS

COMMODITY		FROM OUT OF STATE	FROM IN STATE	TOTAL	% INBND FROM OUT OF STATE	% GROWTH FROM PREV YEAR	ANNUAL % OF ALL CMDTYS INBND
PRIMARY METAL PRODS	12						
	1969	4978926	1697773	6676699	74.5	.0	1.6
	1970	6338168	1570623	7908791	80.1	18.4	1.8
	1971	5894113	1420560	7314673	80.5	-7.5	1.7
	1972	6129518	1667185	7796703	78.6	6.5	1.7
	1973	6247450	1520439	7767689	80.4	-.3	1.8
	1974	7126299	983711	8110010	87.8	4.4	1.8
	1975	5782954	832189	6615143	87.4	-18.4	1.5
	1976	5711640	627417	6339057	90.1	-4.1	1.4
FABRICAT METAL PROD	13						
	1969	662192	133942	796134	83.1	.0	.1
	1970	386304	117274	503578	76.7	-36.7	.1
	1971	949722	94672	1044394	90.9	107.3	.2
	1972	446906	91576	538482	82.9	-48.4	.1
	1973	356813	112542	469355	76.0	-12.8	.1
	1974	274007	104716	378723	72.3	-19.3	.0
	1975	264311	142167	406478	65.0	7.3	.0
	1976	335709	200129	535838	62.6	31.8	.1
SCRAP METALS	14						
	1969	646643	122365	769008	84.0	.0	.1
	1970	711439	123788	835227	85.1	8.6	.1
	1971	619249	80837	700086	88.4	-16.1	.1
	1972	657838	115268	773106	85.0	10.4	.1
	1973	852374	98445	950819	89.6	22.9	.2
	1974	1068121	200252	1268373	84.2	33.3	.2
	1975	645979	162499	808478	79.9	-36.2	.1
	1976	1390839	167555	1558394	89.2	92.7	.3



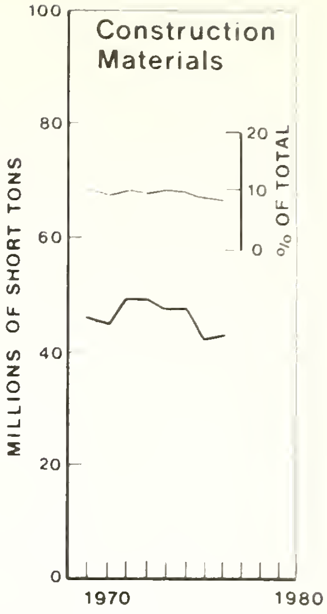


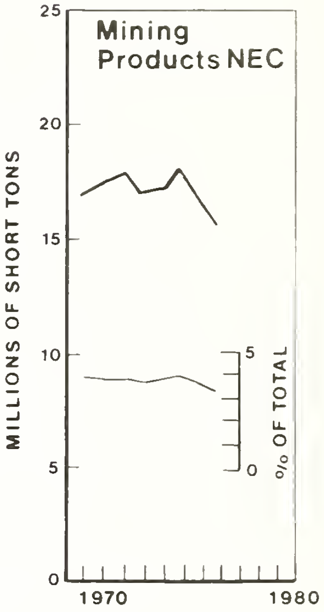


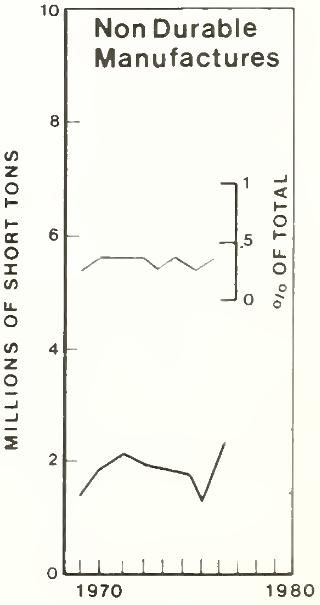
TABULATIONS BY TBS
GRAPHIC PRESENTATION BY TAMS

FIGURE 5
HISTORICAL WATERBORNE COMMODITY MOVEMENTS

COMMODITY		FROM OUT OF STATE	FROM IN STATE	TOTAL	% INBND FROM OUT OF STATE	% GROWTH FROM PREV YEAR	ANNUAL % OF ALL CMDTYS INBND
CONSTRUCTION MATERLS 15							
	1969	18131671	27233949	45365620	39.9	.0	11.2
	1970	18255931	26625743	44881674	40 6	-1.0	10.6
	1971	20281301	28183500	48464801	41.8	7.9	11.2
	1972	20919994	25917631	46837625	44.6	-3.3	10.5
	1973	19277546	28319232	47596778	40.5	1.6	11.1
	1974	21134202	26364495	47498697	44.4	-.2	10.9
	1975	18019658	24035782	42055440	42.9	-11.4	9.7
	1976	19219623	23521108	42740731	44.9	1.6	9.6
MINING PROD NEC 16							
	1969	8468610	8565591	17034201	49.7	.0	4.2
	1970	8394069	9177024	17571093	47.7	3.1	4.1
	1971	8795629	9032741	17828370	49.3	1.4	4.1
	1972	7513055	9679534	17192589	43.6	-3.5	3.8
	1973	7152692	10150987	17303679	41.3	.6	4.0
	1974	7093164	11230532	18323696	38.7	5.8	4.2
	1975	7007597	9891747	16899344	41.4	-7.7	3.9
	1976	7222484	8488692	15711176	45.9	-7.0	3.5
NONDUR MANUF+PROCFDS 17							
	1969	1193841	197753	1391594	85.7	.0	.3
	1970	1660952	191974	1852926	89 6	33.1	.4
	1971	1831203	262119	2093322	87.4	12.9	.4
	1972	1523032	379613	1902645	80.0	-9.1	.4
	1973	1280306	405909	1686215	75.9	-11.3	.3
	1974	1386833	400541	1787374	77.5	5.9	.4
	1975	1144404	182595	1326999	86.2	-25.7	.3
	1976	1630301	583874	2214175	73.6	66.8	.4



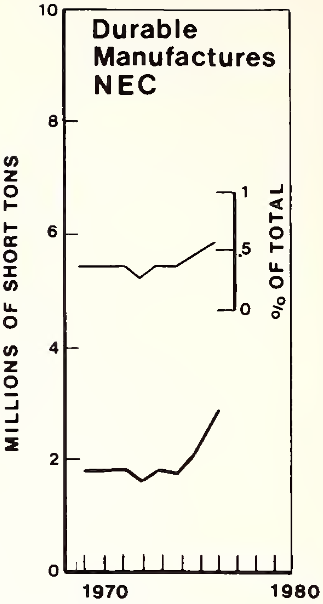


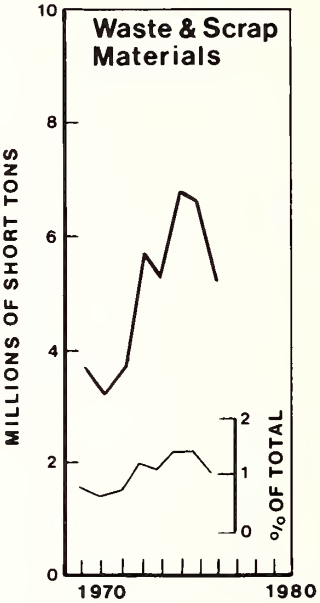


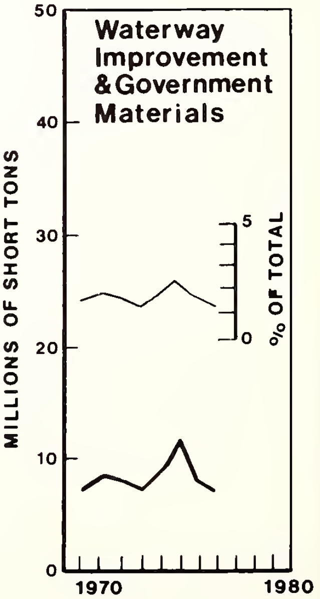
TABULATIONS BY TBS
GRAPHIC PRESENTATION BY TAMS

FIGURE 5
HISTORICAL WATERBORNE COMMODITY MOVEMENTS

COMMODITY		FROM OUT OF STATE	FROM IN STATE	TOTAL	% INBND FROM OUT OF STATE	% GROWTH FROM PREV YEAR	ANNUAL % OF ALL CMDTYS INBND
DURABLE MANUF NES	18						
	1969	470110	1373154	1843264	25.5	.0	.4
	1970	472763	1376295	1849058	25.5	.3	.4
	1971	484174	1346281	1830455	26.4	-1.0	.4
	1972	489519	1180054	1669573	29.3	-8.7	.3
	1973	539810	1277021	1816831	29.7	8.8	.4
	1974	445401	1329344	1774745	25.0	-2.3	.4
	1975	570874	1584653	2155527	26.4	21.4	.5
	1976	793623	2049091	2842714	27.9	31.8	.6
WASTE+SCRAP MATLS	19						
	1969	591004	3085507	3676511	16.0	.0	.9
	1970	592277	2624628	3216905	18.4	-12.5	.7
	1971	804477	2889426	3693903	21.7	14.8	.8
	1972	1059963	4711930	5771893	18.3	56.2	1.3
	1973	798872	4482172	5281044	15.1	-8.5	1.2
	1974	764346	6051568	6815914	11.2	29.0	1.5
	1975	577633	6039547	6617180	8.7	-2.9	1.5
	1976	632904	4675946	5308850	11.9	-19.7	1.1
WATERWAY IMP+GOV MTL	20						
	1969	5384128	2274380	7658508	70.3	.0	1.8
	1970	5343028	3527712	8870740	60.2	15.8	2.1
	1971	5117685	3126113	8243798	62.0	-7.0	1.9
	1972	4377583	3465050	7842633	55.8	-4.8	1.7
	1973	6198105	3115575	9313680	66.5	18.7	2.1
	1974	6481094	5442427	11923521	54.3	28.0	2.7
	1975	4938369	3525078	8463447	58.3	-29.0	1.9
	1976	4650524	2686661	7337185	63.3	-13.3	1.6

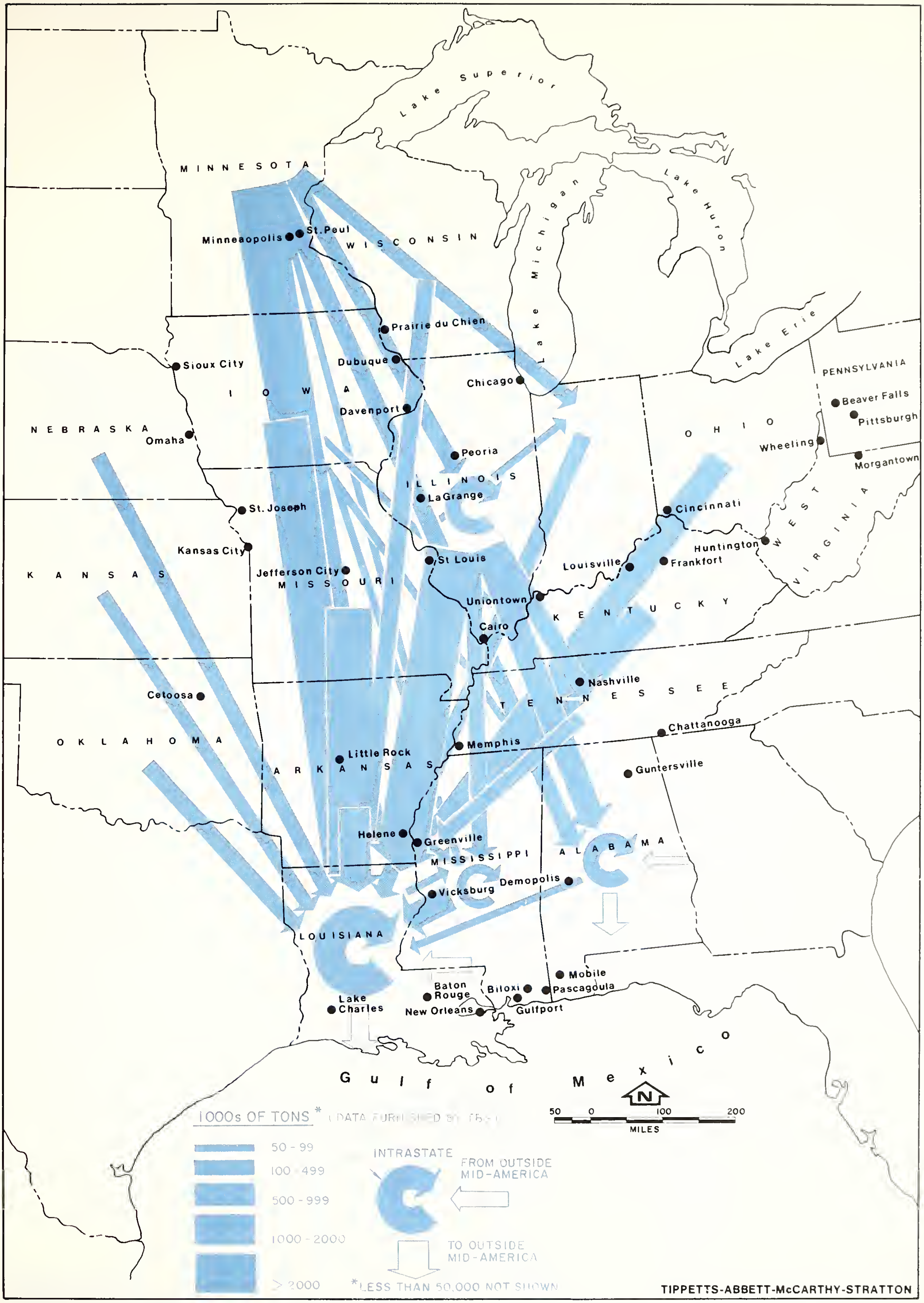






TABULATIONS BY TBS
GRAPHIC PRESENTATION BY TAMS

FIGURE 5
HISTORICAL WATERBORNE COMMODITY MOVEMENTS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WISCONSIN
IOWA
NEBRASKA
ILLINOIS
MISSOURI
KANSAS
OKLAHOMA
ARKANSAS
MISSISSIPPI
ALABAMA
LOUISIANA
TENNESSEE
KENTUCKY
OHIO
WEST VIRGINIA
PENNSYLVANIA
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Minneaopolis
St. Peul
Prairie du Chien
Dubuque
Sioux City
Chicago
Davenport
Omaha
Peoria
LaGrange
St. Joseph
Kansas City
Jefferson City
St Louis
Cincinnati
Beaver Falls
Pittsburgh
Wheeling
Morgantown
Huntington
Frankfort
Louisville
Uniontown
Cairo
Nashville
Cetoosa
Memphis
Chattanooga
Guntersville
Little Rock
Helene
Greenville
Demopolis
Vicksburg
Mobile
Pascagoula
Biloxi
Gulfport
Baton Rouge
New Orleans
Lake Charles
Gulf of Mexico
N
50 0 100 200
MILES
1000s OF TONS * (DATA FURNISHED BY TBS)
50 - 99
100 - 499
500 - 999
1000 - 2000
> 2000
INTRASTATE
FROM OUTSIDE MID-AMERICA
TO OUTSIDE MID-AMERICA
*LESS THAN 50,000 NOT SHOWN
TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 6A ORIGIN - DESTINATION COMMODITY FLOWS, GRAINS

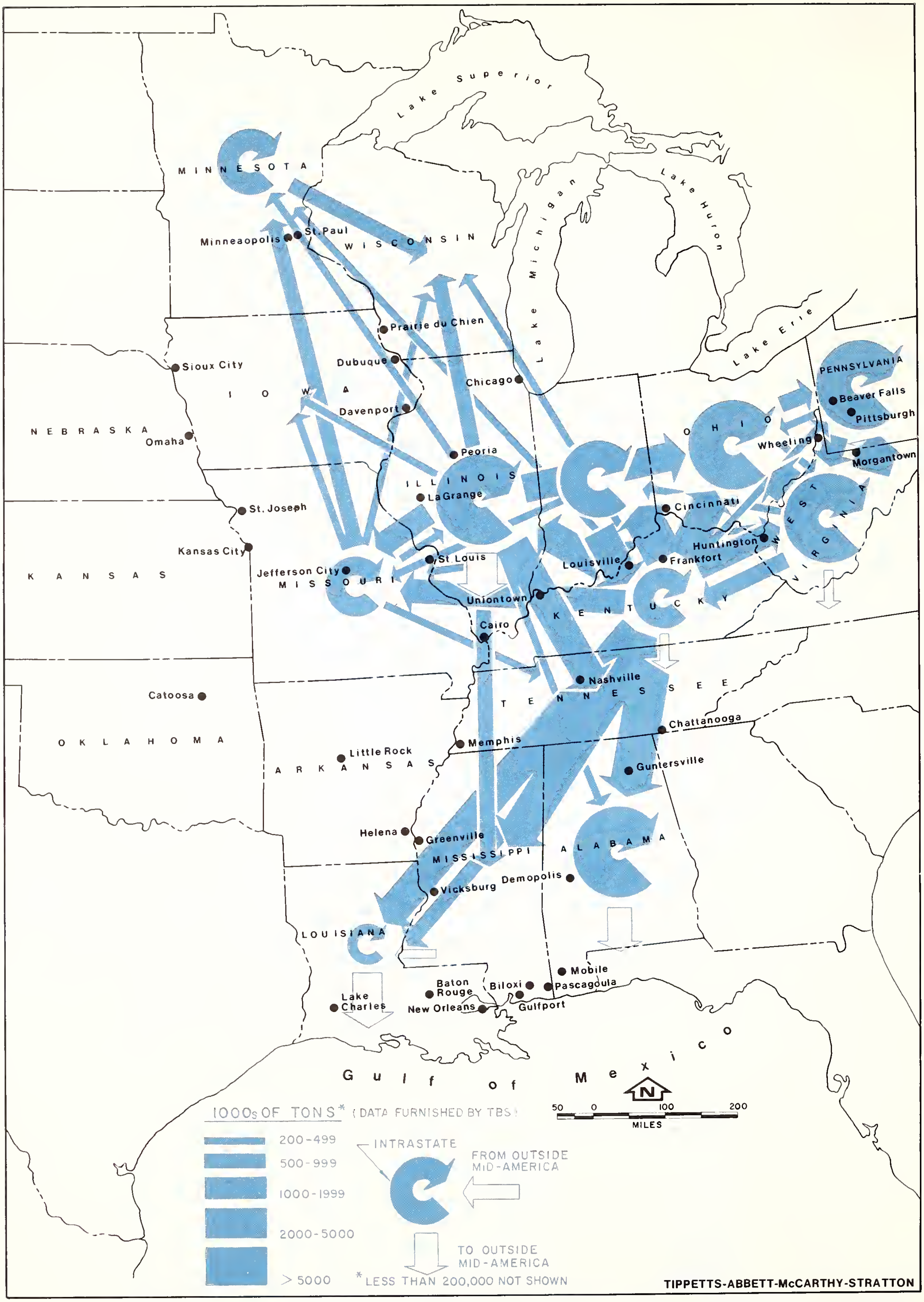
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
MINNESOTA
Minneapolis
St. Paul
WISCONSIN
Prairie du Chien
Sioux City
IOWA
Dubuque
Chicago
Davenport
NEBRASKA
Omaha
Peoria
ILLINOIS
La Grange
St. Joseph
Kansas City
KANSAS
Jefferson City
MISSOURI
St Louis
Uniontown
Cairo
Louisville
Cincinnati
Frankfort
Huntington
KENTUCKY
OHIO
Wheeling
PENNSYLVANIA
Beaver Falls
Pittsburgh
Morgantown
WEST VIRGINIA
Nashville
TENNESSEE
Chattanooga
Catoosa
OKLAHOMA
Little Rock
ARKANSAS
Memphis
Guntersville
Helena
Greenville
MISSISSIPPI
ALABAMA
Vicksburg
Demopolis
LOUISIANA
Lake Charles
Baton Rouge
New Orleans
Biloxi
Gulfport
Mobile
Pascagoula
Gulf of Mexico
N
50 0 100 200
MILES
1000s OF TONS* (DATA FURNISHED BY TBS)
200-499
500-999
1000-1999
2000-5000
> 5000
INTRASTATE
FROM OUTSIDE MID-AMERICA
TO OUTSIDE MID-AMERICA
* LESS THAN 200,000 NOT SHOWN
TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 6B ORIGIN - DESTINATION COMMODITY FLOWS, COAL

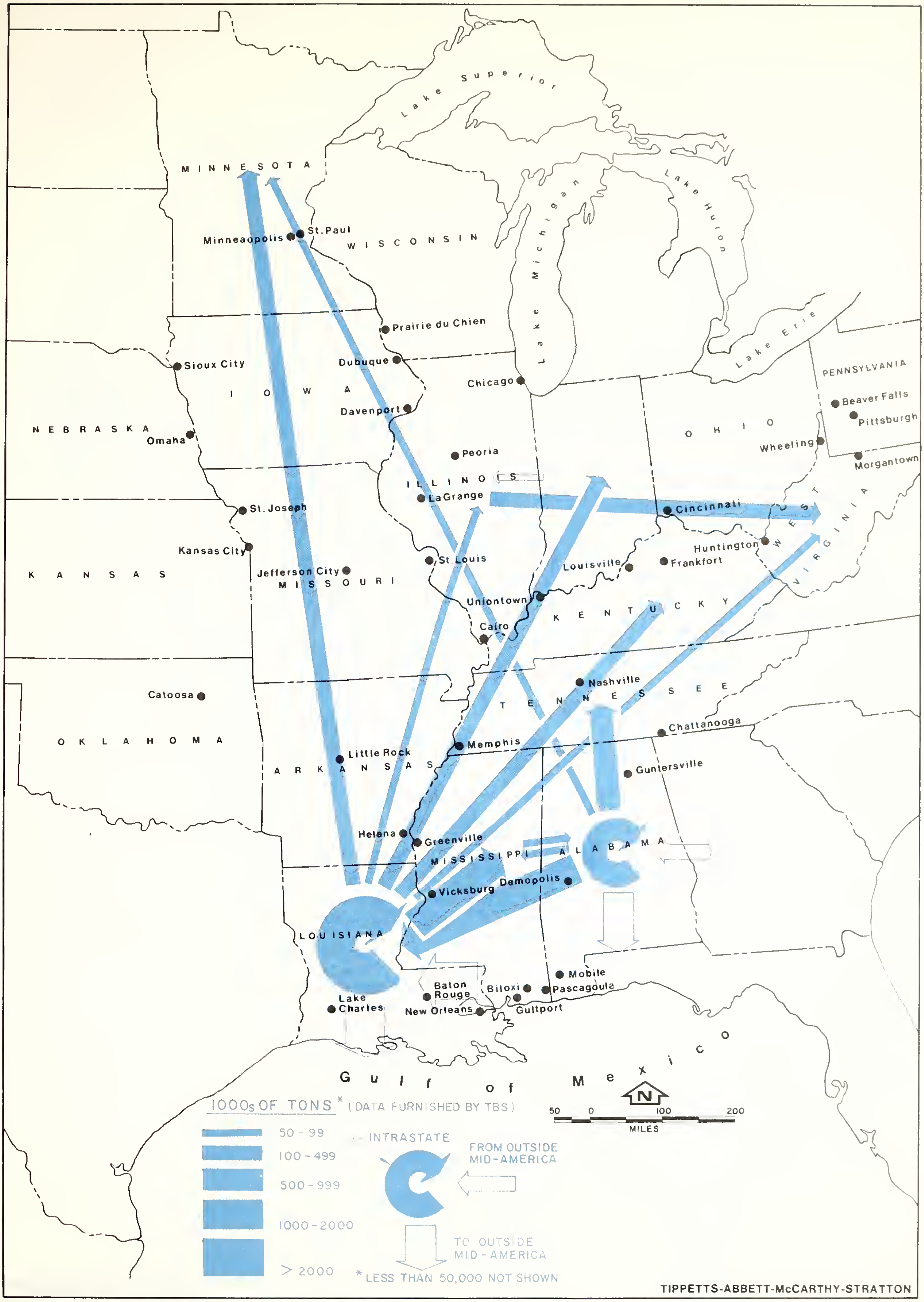
MINNESOTA
WISCONSIN
IOWA
NEBRASKA
KANSAS
MISSOURI
OKLAHOMA
ARKANSAS
ILLINOIS
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
LOUISIANA
OHIO
PENNSYLVANIA
WEST VIRGINIA
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Gulf of Mexico
Minneapolis
St. Paul
Prairie du Chien
Sioux City
Dubuque
Davenport
Chicago
Omaha
Peoria
LaGrange
St. Joseph
Kansas City
Jefferson City
St. Louis
Cincinnati
Beaver Falls
Pittsburgh
Wheeling
Morgantown
Huntington
Frankfort
Louisville
Uniontown
Cairo
Nashville
Catoosa
Memphis
Chattanooga
Guntersville
Little Rock
Helena
Greenville
Vicksburg
Demopolis
Mobile
Pascagoula
Biloxi
Gulfport
Baton Rouge
New Orleans
Lake Charles
1000s OF TONS* (DATA FURNISHED BY TBS)
50 - 99
100 - 499
500 - 999
1000 - 2000
> 2000
INTRASTATE
FROM OUTSIDE MID-AMERICA
TO OUTSIDE MID-AMERICA
* LESS THAN 50,000 NOT SHOWN
N
50 0 100 200
MILES
TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 6C ORIGIN - DESTINATION COMMODITY FLOWS, CRUDE OIL

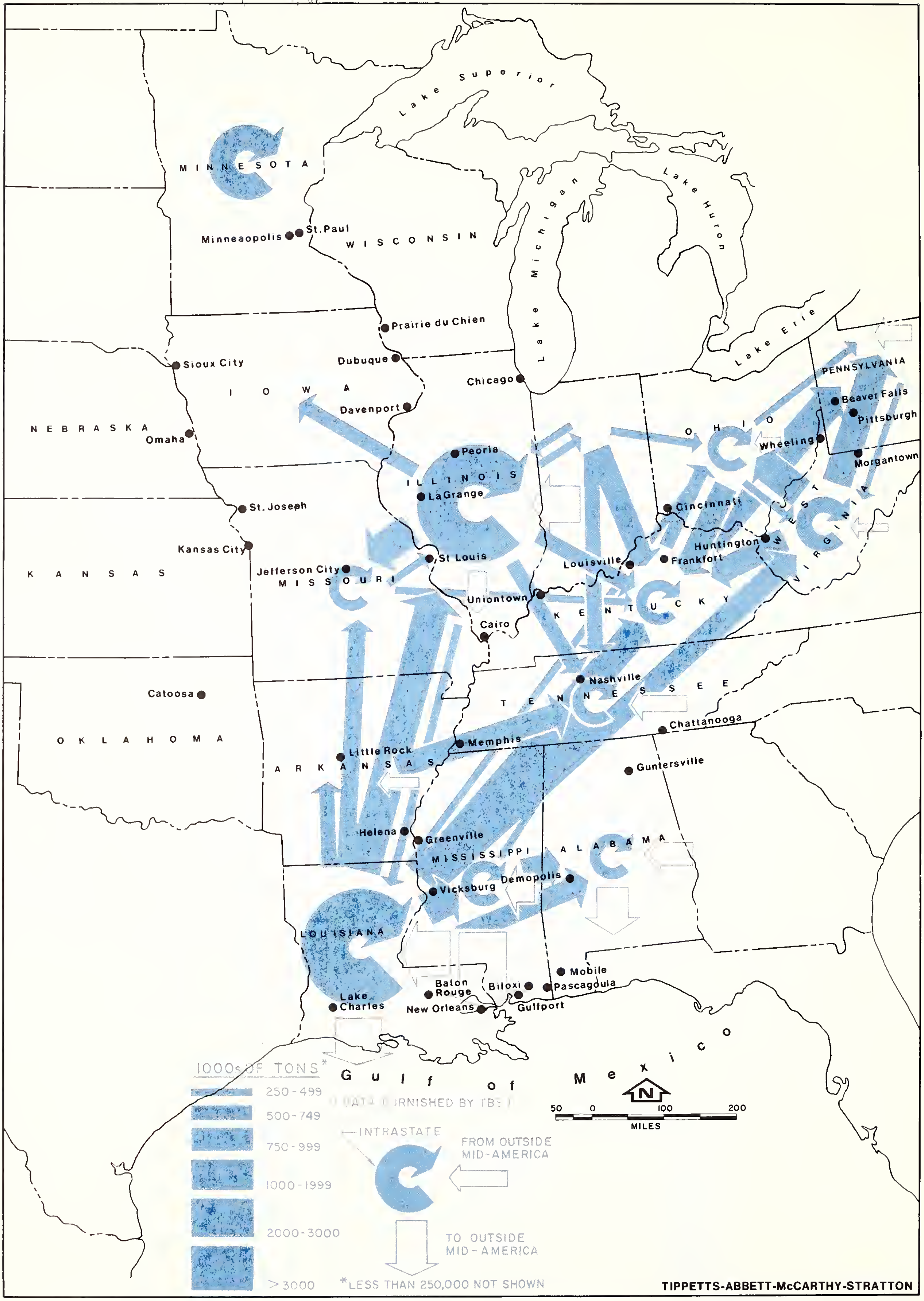
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
MINNESOTA
WISCONSIN
IOWA
NEBRASKA
KANSAS
MISSOURI
OKLAHOMA
ARKANSAS
ILLINOIS
OHIO
PENNSYLVANIA
WEST VIRGINIA
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
LOUISIANA
Minneapolis
St. Paul
Prairie du Chien
Sioux City
Dubuque
Chicago
Davenport
Omaha
Peoria
LaGrange
St. Joseph
Kansas City
Jefferson City
St Louis
Uniontown
Cairo
Louisville
Cincinnati
Frankfort
Huntington
Wheeling
Beaver Falls
Pittsburgh
Morgantown
Nashville
Chattanooga
Guntersville
Catoosa
Memphis
Little Rock
Helena
Greenville
Vicksburg
Demopolis
Baton Rouge
Lake Charles
New Orleans
Biloxi
Gulfport
Mobile
Pascagoula
Gulf of Mexico
1000s OF TONS*
250 - 499
500 - 749
750 - 999
1000 - 1999
2000 - 3000
>3000
(DATA FURNISHED BY TBS)
INTRASTATE
FROM OUTSIDE MID-AMERICA
TO OUTSIDE MID-AMERICA
*LESS THAN 250,000 NOT SHOWN
N
50 0 100 200
MILES
TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 6D ORIGIN - DESTINATION COMMODITY FLOWS, PETROLEUM PRODUCTS

CHAPTER 5
PORT FACILITIES INVENTORY

The first comprehensive inventory of the nation's inland waterway port terminals was performed by the 17 participating Mid-America Ports Study states and the Maritime Administration (MarAd). This was a cooperative effort: MarAd provided technical guidance, management coordination and data processing; the states conducted the field surveys and collected the terminal data.

MarAd supplied the study consultant with a computer tape of the raw inventory data. These data formed the basis for the technical evaluation of cargo handling capacity and projection of port facility needs described in subsequent chapters. This chapter briefly describes the facility inventory process and then summarizes the results of the statistical tabulations of terminal facility characteristics. A total of 1,198 port facilities comprises the Mid-America Ports Study inventory.

FACILITY INVENTORY PROCESS

Each participating state had responsibility for inventorying the inland terminal facilities within the state. All facilities handling commercial waterborne cargo, publicly or privately owned, were to be included. In general, facilities used for other purposes such as vessel repair and maintenance, vessel construction, tow/barge servicing and recreational craft were to be excluded. While every reasonable attempt was made to perform a comprehensive, complete inventory of terminal facilities, it is evident, based upon a review of available information, that the inventory as now constituted represents less than a 100 percent sample; it appears that some state inventories are relatively complete while other states have major omissions.

The Port Facility Inventory Form

Each facility was inventoried on a separate "Port Facilities Inventory" form, consisting of 389 separate data elements, all of which do not necessarily pertain to each terminal. The following types of information were obtained:

a) Location -- by river mile, bank location, city and state;

b) Fleeting area characteristics;

c) Pier dimensions and construction characteristics;

d) Type of cargo handled;

e) Availablility of truck and rail access;

f) Cargo storage areas separately for containers, break-bulk, bulk commodities and grains and by inside and outside storage;

g) Types and characteristics of handling equipment separately for general cargo, bulks (dry and liquid) and grains.

The form was designed so that all data could be readily input to computer for subsequent processing. A copy of the complete form, along with instructions and a coding sheet prepared by MarAd, appear in Appendix B.

Data Processing

Completed inventory forms were transmitted by the states to MarAd. In turn, MarAd had the data key-punched and placed on computer tape for subsequent processing. Programs written by the Consultant to assess and analyze the facility data were written in COBOL.

The Consultant was provided with a computer tape containing the facility data. The results of the analyses of the inventory data are described in the following sections.

INVENTORY FINDINGS

Number of Terminals

The 1198 waterway terminals in the inventory are distributed among the states as shown in Table 5-1.

Almost 70 percent of the terminals inventoried handle materials in only one of the 23 classifications of cargo types used in the inventory.* An additional 15 percent handle two cargo types; the remainder handle three or more cargo types. Terminals identified as single-cargo facilities may actually handle a variety of goods within one cargo type inasmuch as the categories are broadly defined. It is clear, however, that most river terminals are dedicated to the transshipment of commodities with similar handling characteristics.

The classifications of cargo types used herein for the inventory summaries are listed below. The letters indicated below correspond to the cargo types listed in Figure 7.

- General Cargo: Cargo types A, B, C**, D, H, V, W;
- Solid Bulks: Cargo types E, F, G, I, P, Q;
- Liquid Bulks: Cargo types J, K, L, M, N, R, S, T, U.
- Grains: Cargo type O.

Of the single cargo facilities, 36 percent handle cargo types identified as liquid bulks. Solid bulk terminals account for 33 percent of the single cargo facilities, while grain and general cargo account for 18 percent and 13 percent, respectively.

The system of categorization introduces an element of imprecision to the evaluations of cargo handling capability of each terminal (as described in detail in Chapter 15); some cargo types include commodities with markedly different

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* See Appendix B for list of cargo types.

** Only three facilities in the inventory handle cargo type C, Passengers Only.

TABLE 5-1

FACILITIES IN INVENTORY

State	Number
Alabama	46
Arkansas	27
Illinois	173
Iowa	69
Kansas	16
Kentucky	98
Louisiana	157
Minnesota	70
Mississippi	36
Missouri	83
Nebraska	18
Ohio	86
Oklahoma	18
Pennsylvania	72
Tennessee	141
West Virginia	66
Wisconsin	22
Total	1,198

handling characteristics. Three cargo types are significantly affected by this problem. Cargo type I, Fertilizer, includes commodities which can be handled as solid bulk, liquid bulk or general cargo, but all fertilizer terminals are classified in the inventory summaries as solid bulk facilities. Cargo type S includes miscellaneous cargoes with varying handling characteristics, yet all facilities handling type S cargoes are classified in the liquid bulk category.* Finally, the bulk handling characteristics assumed for grains, cargo type O, are inappropriate for bagged grains.

Figure 7 shows the distribution of inventoried facilities by cargo type; facilities handling several cargo types were multiple-counted once in deriving the figure. The most commonly handled cargo is Refined Petroleum Products which is handled at almost a fourth of all terminals in the inventory; 15 percent of all terminals are dedicated exclusively to this cargo type. Other commonly handled cargo types are Coal and Coke Products, Non-metallic Minerals and Grain.

General cargoes (i.e., cargo types A, B, C, D, H, V, W), including both single cargo and multiple-cargo facilities, are handled at 23 percent of all terminals. Solid and liquid bulks each are handled at 43 percent of all terminals, and grains are handled at 18 percent. About one-fourth of all terminals transship goods in two or more of these categories.

Storage Characteristics

Table 5-2 summarizes the storage area available in each state for general cargo and for dry bulks. Not all the terminals supplied this information, and it is not known to what extent survey respondents may have included undeveloped or unusuable areas in the storage area figures.

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* About 60 percent of the inventory terminals handling cargo type S are liquid bulk facilities.

TABLE 5-2

STORAGE AREAS, BY STATE
GENERAL CARGO & DRY BULKS

	General Cargo		Dry Bulk	
State	Inside Storage (000 ft.^{2})	Yard Storage (acres)	Inside Storage (000 ft.^{2})	Outside Storage (acres)
Alabama	1,736	453	50	69
Arkansas	302	102	692	60
Illinois	1,127	519	2,785	948
Iowa	179	112	981	234
Kansas	1,300	40	0	0
Kentucky	310	102	0	158
Louisiana	5,199	150	40	59
Minnesota	501	95	276	384
Mississippi	1,333	83	0	10
Missouri	155	310	20	3
Nebraska	127	27	535	20
Ohio	1,784	80	535	527
Oklahoma	190	235	65	35
Pennsylvania	6,532	119	1,443	476
Tennessee	148	73	438	745
West Virginia	90	38	10	132
Wisconsin	0	16	0	79
Total	21,013	2,554	7,870	3,939

Total Inside Storage (000 ft.^{2})	28,883
Total Yard/Outside Storage (acres)	6,493
Total Storage, Inside & Yard/Outside (acres)	7,148

Source: Port Facility Inventory

A total of 21,000 square feet of inside storage and 2,554 acres of yard storage are utilized by general cargo terminals. Pennsylvania, followed by Louisiana have over 50 percent of the study area's inside storage area. The total inside and outside areas in Mid-America devoted to the storage of dry bulks is about 4,100 acres. In sum, over 7,000 acres are utilized for the storage of general cargo and dry bulk cargoes.

Instantaneous storage capacities (i.e., storage capacities at any given point in time as opposed to annual storage capacities), for dry bulks, liquid bulks and grains are given in Table 5-3. Once again, this information was not supplied by every terminal handling these cargoes and may be understated.

The total instantaneous study area storage capacity for dry bulks is 147 million long tons, 42 percent of which is located in Ohio. Almost 337 million barrels of storage for liquid bulks is located in the study area, 50 percent of which is located in the states of Louisiana and Minnesota. Grain storage totals 356 million bushels, almost 25 percent of which is located in Minnesota.

A graphic comparison of reported storage characteristics is presented for each state in Figure 8.

Handling Equipment

Table 5-4 displays the number of pieces of handling equipment reported in the inventory for general cargo, dry bulk and bulk grain terminals. For general cargo handling equipment, "Fork Lifts" was the most common unit, representing 34 percent of the 660 pieces of equipment reported in the inventory. General Cargo/Container Crane at 14 percent and Yard Crane at eight percent were the next two most frequent categories. For dry bulk handling equipment, Conveyor Belt System, Crane with Clamshell Bucket, and Front End Loader are the most common categories, representing 20 percent, 19 percent and 19

TABLE 5 -3

STORAGE CAPACITIES, BY STATE
DRY BULKS, LIQUID BULKS & GRAINS

State	Dry Bulks* (000 long tons)	Liquid Bulks (000 barrels)	Grains (000 bushels)
Alabama	9,285	1,364	5,756
Arkansas	286	2,259	24,544
Illinois	24,958	52,238	44,747
Iowa	3,088	53,576	13,339
Kansas	0	1,294	32,987
Kentucky	15,846	6,391	9,250
Louisiana	566	86,450	39,054
Minnesota	5,900	79,803	86,245
Mississippi	2,350	5,940	30,737
Missouri	935	8,313	30,960
Nebraska	130	2,003	9,535
Ohio	61,748	12,553	2,678
Oklahoma	282	345	1,515
Pennsylvania	7,557	10,884	0
Tennessee	5,305	9,456	23,656
West Virginia	6,070	2,919	0
Wisconsin	2,800	848	630
Total	147,107	336,636	355,523

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* Inside and Outside Capacity.

Source: Port Facility Inventory

TABLE 5-4

GENERAL CARGO, DRY BULK, AND BULK GRAIN HANDLING EQUIPMENT

(Number of Pieces of Equipment Reported in Inventory)

Handling Equipment Type	AL	AS	IL	IA	KA	KY	LA	MN	MS	MO	NB	OH	OK	PA	TN	WV	WI	TOTAL
GENERAL CARGO																		
General Cargo/Container Crane	1	9	24	1	--	--	9	--	6	9	2	18	4	7	1	2	--	93
Container Crane	3	--	1	--	1	--	4	1	1	--	--	2	--	--	--	--	--	13
Straddle Carrier	--	--	1	--	--	--	--	--	2	--	--	--	--	--	--	--	--	3
Lift Truck with Spreader	--	--	3	--	--	--	--	--	--	--	--	--	--	--	1	--	--	4
Yard Crane - Other	2	9	18	--	--	--	--	2	1	2	3	1	4	3	--	6	3	54
Locomotive Crane	32	--	1	--	--	--	--	--	--	--	--	--	--	1	3	--	--	37
Front End Loader	--	8	16	--	--	--	--	--	3	--	4	10	1	3	5	1	1	52
Crane with Magnet	--	1	6	2	--	--	--	1	7	--	--	2	--	3	--	--	--	22
Crane with Clamshell Bucket	--	5	11	3	--	--	--	6	2	6	1	7	1	5	3	--	2	52
Bridge Crane	--	3	3	--	--	--	--	--	--	--	--	--	--	3	4	--	--	13
Fork Lifts	--	36	82	13	--	--	--	5	40	--	2	23	7	6	9	1	1	225
Shoreside RO/RO Ramp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	3	--	4
Other	--	8	30	--	--	--	2	5	6	6	8	2	1	8	4	6	1	88
TOTAL GENERAL CARGO	38	79	196	19	1	--	15	20	68	23	20	66	18	39	31	19	8	660
DRY BULK																		
General Cargo/Container Crane	--	1	--	--	--	--	--	1	--	--	--	1	--	--	10	2	--	15
Yard Crane - Other	--	1	18	2	--	--	6	3	--	1	--	4	--	1	2	3	2	43
Shiploader 1/	5	2	13	1	--	--	7	3	1	1	--	1	--	--	1	1	--	36
Gantry Crane Unloader, Single Bucket	1	--	10	--	--	--	16	2	--	4	--	10	--	7	--	1	--	51
Pneumatic Loader	--	--	--	--	1	--	--	--	2	1	--	4	--	--	--	--	--	8
Pneumatic Unloader	--	--	5	--	--	--	--	2	1	2	--	3	--	--	4	--	--	17
Marine Leg (Continuous Bucket)	3	--	5	--	--	--	--	--	1	2	--	3	--	3	2	1	--	20
Gravity Chute Loading Spout	--	--	2	1	--	--	2	--	--	--	--	8	--	4	--	2	--	19
Locomotive Crane	--	--	4	1	--	--	--	--	--	--	--	--	--	--	13	--	--	18
Front End Loader	--	13	15	17	--	--	--	11	--	--	6	78	2	19	26	4	2	193
Crane with Clamshell Bucket	--	4	30	18	--	--	--	10	1	2	1	54	1	32	35	4	4	196
Bridge Crane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15	--	2	17
Bulldozer	--	--	3	1	--	--	--	--	--	--	--	1	--	9	4	1	--	19
Conveyor Belt System	1	6	16	13	--	--	2	16	--	7	1	56	7	32	15	27	--	199
Other	--	5	57	1	--	--	1	9	--	7	2	18	--	8	40	--	2	150
TOTAL DRY BULK	10	32	178	55	1	--	34	57	6	27	10	241	10	120	167	46	12	1,006
BULK GRAIN																		
Shiploader 1/	--	10	19	1	--	--	12	2	--	2	--	1	--	--	--	--	--	47
Pneumatic Loader	--	--	--	--	--	--	--	--	1	1	--	--	--	--	--	--	--	2
Pneumatic Unloader	--	--	--	--	--	--	--	--	1	--	--	--	--	--	1	--	--	2
Marine Leg (Continuous Bucket)	2	--	8	--	--	--	3	1	4	--	1	--	--	--	8	--	--	27
Gravity Chute Loading Spout	--	2	30	--	--	--	22	10	10	1	1	1	--	--	3	--	1	81
Crane, Clamshell Bucket	--	--	3	--	--	--	--	2	1	--	--	--	--	2	1	--	--	9
Conveyor Belt System	--	9	26	1	5	--	--	11	1	8	12	2	10	1	24	--	--	110
Auger	--	--	--	2	--	--	--	--	--	--	--	--	--	--	2	--	--	4
Other	18	4	4	--	--	--	--	1	--	5	--	--	--	3	3	--	--	38
TOTAL BULK GRAIN	20	25	90	4	5	--	37	27	18	17	14	4	10	6	42	--	1	320

1/ Slewing chute, gravity loader, conveyor belt feed.

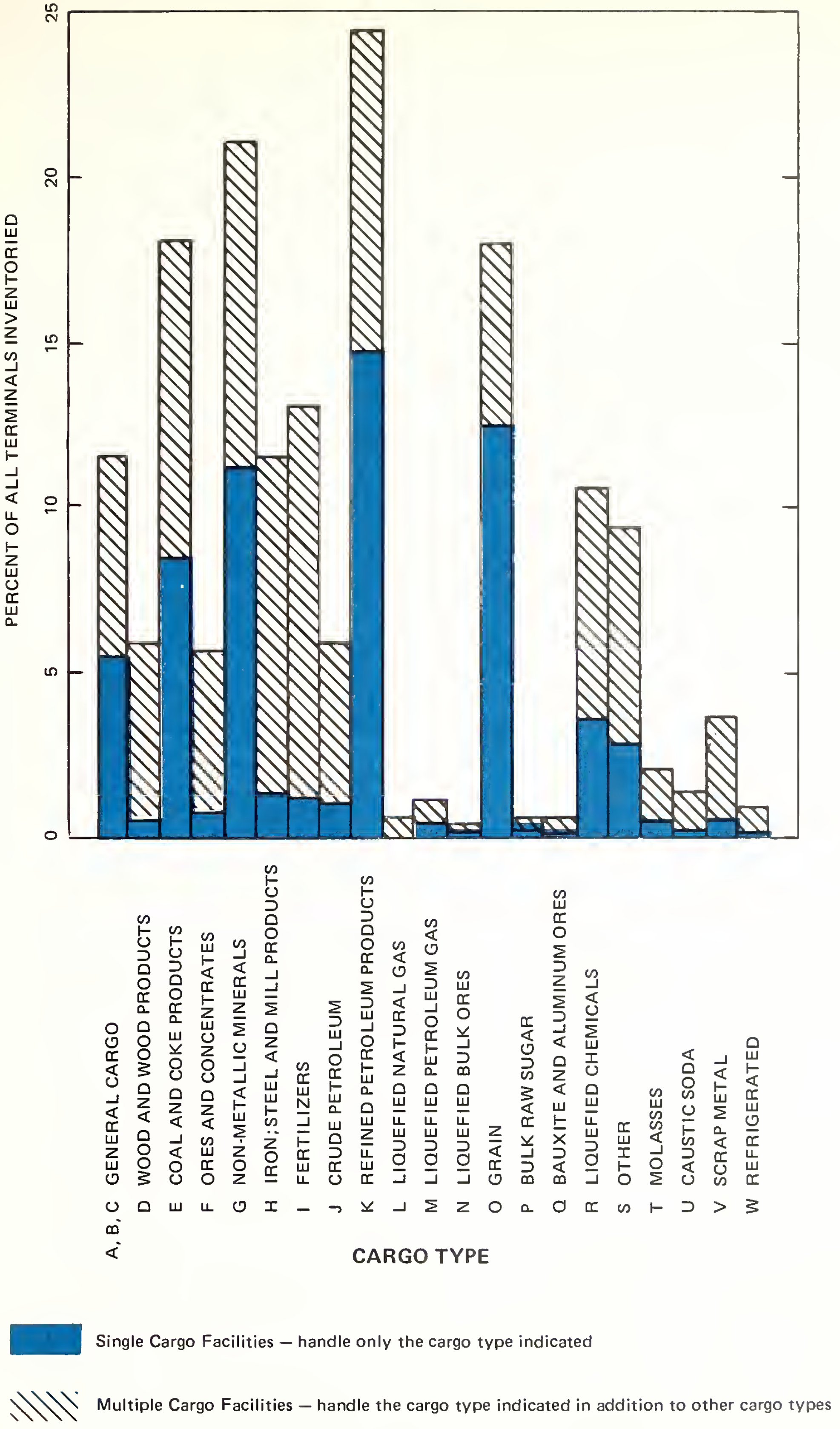
Source: Port Facility Inventory

percent, respectively of the 1,006 pieces of equipment reported. For bulk grains, Conveyor Belt System and Gravity Chute Loading Spout were most frequently reported, representing 34 percent and 25 percent, respectively of the 320 pieces reported. The characteristics of existing liquid bulk handling equipment are discussed in Chapter 8 , along with a review of existing cargo handling rates.

Related Appendix Material

Separately bound appendices have been prepared for each state. Appendix I contains the following inventory tables:

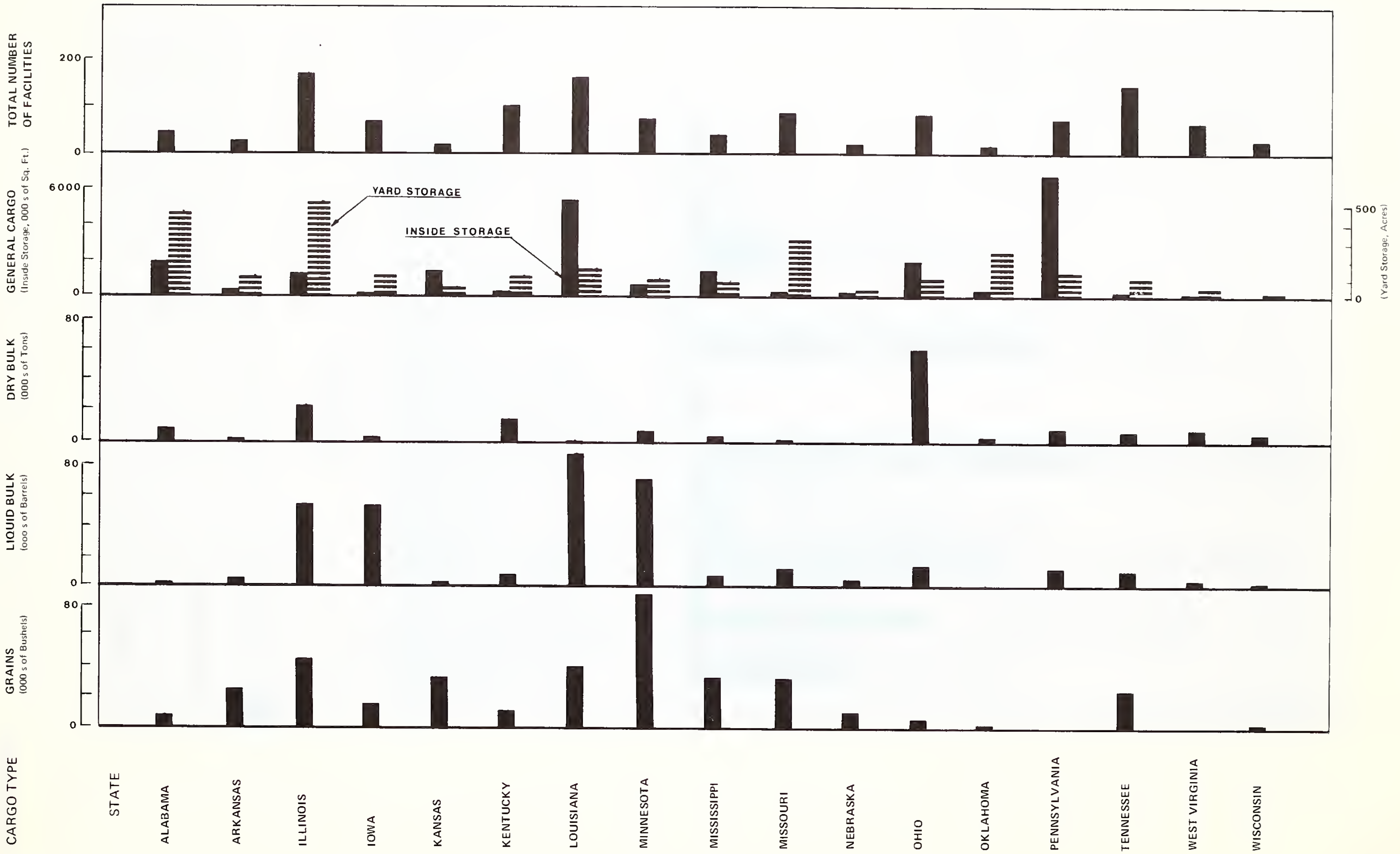
- Terminal listing, classification and cargo type, by state and subregion;
- Number of facilities by cargo type and ownership classification, subregion;
- General cargo/container/Ro-Ro/LASH-SeaBee facilities, storage areas by subregion;
- Dry bulk terminal facilities, storage areas and storage capacities by subregion;
- Liquid bulk terminal facilities, storage capacities by subregion;
- Bulk grain terminal facilities, storage capacities, by subregion;
- All terminal facilities, number of pieces of handling equipment by type, and subregion.



NOTE:

Sum of percentages shown is greater than 100 because multiple cargo facilities are counted once for each cargo type handled.

FIGURE 7 CARGO TYPES HANDLED AT EXISTING FACILITIES



TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 8 CARGO STORAGE SPACE BY CARGO TYPE AND BY STATE

CHAPTER 6

EXISTING TRANSPORTATION SYSTEMS

This chapter examines the study area's existing transportation network. The physical characteristics of three modal areas are described: waterways, railroads, and pipelines. In addition, data concerning present traffic volumes on the railroads and pipelines are presented; commodity flow data for the waterways were presented in Chapter 4.

Of particular interest for the waterways system are constraining factors which might divert traffic to other modes; the constraints are dealt with in this chapter in a general fashion, while projections of specific constraints are contained in Chapter 10.

Railroads and pipelines are examined in this study because they compete with waterborne transport for the movement of commodity traffic. Truck and air freight, are not analyzed inasmuch as they are not competitive with water carriers for line-haul cargoes. Trucks and air freight carriers are generally most suitable for high unit value commodities which are not ordinarily carried on the inland waterways. Trucks may, however, compliment a waterway movement.

WATERWAYS

Components of the Inland Waterways System

The inland waterways in the study area, as shown in Figure 1, consist of:

1. The Mississippi and her tributaries including the Minnesota, Missouri, Arkansas, Ouachita, Illinois Waterway, Ohio, Kaskaskia, Monongahela, Allegheny, Kanawha, Kentucky, Green, Cumberland, Tennessee Rivers and minor tributaries;

2. The Gulf Rivers including the Gulf Intracoastal waterway, Lake Charles, Calcasieu River, Sabine River, Atchafalaya River, Port Allen-Morgan City route, Pearl River and minor tributaries and outlets to the Gulf;

3. Alabama's river system including the Mobile, Tombigbee, Black Warrior, Alabama, Coosa and Chattahoochee Rivers and minor tributaries.

The Illinois Waterway permits access to the Mississippi River system from Lake Michigan. The Mississippi is linked to the Gulf of Mexico by several outlets: the mouths of the Mississippi; Gulf Seaway (Mississippi River-Gulf Outlet); Gulf Intracoastal Waterway via the Harvey, Algiers, or Inner Harbor Navigational Canal; Port Allen-Morgan City route; and Atchafalaya River. The Corps of Engineers has a project underway which will connect the Tennessee and Tombigbee Rivers, permitting access to the Mississippi River system through Mobile.

The Cumberland and Tennessee Rivers are joined by a canal above the Barkley and Kentucky Locks, which enables vessels on the two rivers to use either lock.

Navigation on the inland waterways is aided by 157 locks maintained by the Corps of Engineers (Figure 9).

Waterways Projects

A total of eight major new waterways projects, either in operation, under construction, or authorized for construction, have been identified, when fully or partially operational, will have a potentially major impact upon the flow of commerce in the study area. Table 6-1 summarizes these projects, each of which has been examined in this study for their commerce impact. There are a number of other waterway projects under consideration, such as the White River Deepening Study, which are in various pre-feasibility/feasibility phases of study; only those projects which, at a minimum, are authorized, have been considered in this analysis.

TABLE 6-1

WATERWAYS PROJECTS

Project Name	Project Status Estimated Completion Date
Arkansas River	Operating/NA
Ouachita River (to Camden, Ark.)	Operating and under construction/1984
Kaskaskia River	30 miles completed/1980
Tennessee-Tombigbee Waterway	Under construction/1984-86
Red River-Mississippi River to Shreveport, La.	Authorized/1985
Red River-Shreveport, La to Dangerfield, Tx.	Authorized/1990
Yazoo River	Authorized/1990
Coosa River	Authorized/1990

Under legislation enacted by Congress in 1978* , the Secretary of the Army is prohibited from undertaking any replacement, construction or rehabilitation of locks, dams, and channels to increase the navigational capacity of the Upper Mississippi River System** until a master plan for management of the system is approved. The master plan is to be prepared by the Upper Mississippi River Basin Commission and submitted to Congress by January 1, 1982. Excluded from this prohibition are the replacement of Locks and Dam 26 and any necessary operating and maintenance activities. Furthermore, all Federal officials are prohibited from studying the feasibility of deepening the navigation channels in the Upper Mississippi River System unless specifically authorized by a future Act of Congress.

---

* PL 95-502, Title I - Replacement of Locks and Dam 26; Upper Mississippi River System Comprehensive Master Management Plan.

** Defined as "those river reaches containing commercial navigation channels on the Mississippi River main stem north of Cairo, Illinois, the Minnesota River, Minnesota; Black River, Wisconsin; Saint Croix River, Minnesota and Wisconsin; Illinois River and Waterway, Illinois; and Kaskaskia River, Illinois."

Constraints on Waterway Capacity

Constraints on waterway capacity are introduced by factors which:limit the dimensions or speed of tows; preclude year-round navigation; delay a tow; or prevent fleeting operations. Such constraints can increase the cost of waterborne transportation and may divert cargo movements to competing modes or alternate water routes.

Constraints may be related to any one or combination of elements discussed below:

- Locks
- Channel dimensions
- River conditions
- River frontage

Locks

The function of a lock is to transfer vessels from one water level to another. Locks can constrain waterway capacity directly or indirectly by their chamber dimensions. A direct constraint would be a lock chamber too small to permit passage of a vessel. An indirect constraint would result when the size of the chamber mandates the breaking up and reassembly of tows, incurring a time loss to the shipper. The degree of constraint imposed by a lock will also be affected by lockage time and by traffic demand at the lock, as the demand for lockage affects waiting time; a portion of the vessels will experience long waits (relative to lockage time) even at a lightly utilized lock, as discussed in Chapter 10.

The Corps of Engineers adopted standard lock dimensions in 1959 as shown in Table 6-2. These dimensions are compatible with various configurations of standard (175 x 26 ft.)

and jumbo (195 x 35 ft.) barges. A 110 x 600 ft. lock chamber, for example, will fit twelve standard-size barges (four across and three long) or nine jumbo-size modules (three across).

TABLE 6-2

STANDARD LOCK DIMENSIONS

Width (ft.)	Length (ft.)
66	400 or 600
84	600, 800 or 1200
110	600, 800 or 1200

Locks which were designed before 1959 are often of nonstandard dimensions. On the Allegheny, Monongahela, and Kanawah Rivers, locks are 56 ft. wide and 360 ft. long. Chamber widths under 40 ft. are found on the Green, Barren, and Kentucky Rivers, and on Bayou Teche.

By and large, lock design and barge design have influenced each other; at present, the barge industry is in harmony with the Corps on this matter. The 110-foot width has evolved into the standard width. This dimension accommodated tows consisting of four, 26-foot width,early generation barges and will be able to accommodate two of the future generation 52-foot width barges.

New locks are authorized or under construction at a number of Mid-America locations. A new lock and channel are authorized as part of the Mississippi River-Gulf Outlet project to connect the Outlet with the Mississippi. Replacement locks are authorized for Vermilion Lock and L/D 26. L/D Nos. 50 and 51 will be replaced by the Smithland Locks currently under construction. A temporary lock under construction at L/D 53 will accommodate increased commercial traffic, and studies are underway to determine whether L/D Nos. 52 and 53 should be improved or replaced by the authorized Mound City Locks and Dam. Replacement schedules, with the exception of those locks under construction, are highly uncertain and the manner in which new locks and/or locks forecast to reach capacity during the study period are addressed, is discussed in Chapter 10.

Channel Dimensions

Cargo movement on the waterways is subject to the dictates of channel dimensions. Depth, width, curvature and clearance restrict the size of vessels and may limit the cargo-carrying capacity of a waterway.

Channel depth is the most critical of these factors. Dredging operations, dam construction, and cargo transfer between barges and deep draft vessels are all mandated by channel depth considerations.

Most channels on the inland waterways are maintained for 9 foot draft vessels. Controlling drafts for 6 foot vessels are maintained on the Appalachicola, Chattahoochee, Flint, Kentucky and Barren Rivers, and on upper reaches of the Green River and Bayou Teche; and 8 feet on lower Bayou Teche. River conditions on the Missouri limit the controlling draft to 7 feet.

The Old River (La.) and Gulf Intracoastal Waterway are maintained for 12 foot drafts or greater. On the Mississippi, channels are deep enough to permit navigation by oceangoing vessels upstream to Baton Rouge.

The constraining safety effects of river bends and narrow reaches have been mitigated to some extent by electronic navigational aids. However, requirements of maneuverability around bends continue to limit tow lengths.

Overhead clearance restrictions imposed by bridges on the Illinois Waterway have spurred the use of elevating pilot-houses on towboats.

River Conditions

Constraints upon capacity can be imposed by river conditions such as swift currents, low water and freezing.

The Missouri River is an open river without locks and dams. Swift currents and narrow channels limit tow sizes. A 3200 hp towboat is adequate to handle a 12 to 15 barge tow on the Illinois or Upper Mississippi Rivers, but cannot normally handle more than 6 barges on the Missouri.

Flooding on the Arkansas River engenders swift flows which make navigation difficult.

Periods of low water during late summer and fall sometimes restrict tow sizes to about 20 barges on the Lower Mississippi.

Annual freezing on the Missouri and Upper Mississippi can occur between early December and March. The Illinois River freezes about once in 10 years.

River Frontage and Fleeting

It is becoming increasingly difficult to establish new or enlarge existing barge fleeting areas. This problem could conceivably worsen, as the tonnage handled on the waterways increases. Though an analysis and quantification of barge fleeting needs are beyond the scope of this study, it is a matter of major concern to waterway interests which could constraint the movement of waterborne commerce.

River frontage which might otherwise be suitable for fleeting is being preempted for other uses, including recreational and commercial activities. Barge fleeting is an operation analogous to the functions performed in a rail marshalling yard. Fleeting areas are used to store barges and/or to break up and make up tows and are essential for the maintenance of river traffic.

RAILROAD FACILITIES AND TRAFFIC

Class I Railroads Serving the Study Regions*

Of the 59 Class I railroads operating in the United States in 1976, 29 served the 17 states covering the subregions in this study.** As shown in Table 6-3, these companies operated 29,879 miles of mainlines (i.e., lines with more than 5 million gross ton-miles per mile of road annually) in the study region. The mainline mileage of these 29 railroads in the study region, represented 28 percent of their total system mainline mileage (103,868 miles); probable rail abandonments will reduce this mileage. The railroads with most lines (mainline miles)in the study region were:

- Illinois Central Gulf (3,754 miles)
- Conrail (2,796)
- Burlington Northern (2,618)
- Louisville & Nashville (1,995)
- Missouri Pacific (2,106)
- Southern (1,839)
- Chicago, Rock Island and Pacific(2,066)
- Baltimore & Ohio (1,551)
- Norfolk and Western (1,310)
- Chicago, Milwaukee, St. Paul & Pacific (1,383)

These key railroads together accounted for 72 percent of lines operated in the study region. Of these, Chicago, Milwaukee, St. Paul & Pacific, and Chicago, Rock Island and Pacific were described by the Rail Services Planning Office of ICC as

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* In 1976 U.S. railroads with $5.0 million or more of average operating revenue were classified by the Interstate Commerce Commission as Class I railroads. The study region for purposes of this railroad analysis is defined as the area covering 150 miles on either side of the river system.

** The 29 railroads accounted for about 92 percent of both rail route miles and equipment (freight cars and locomotives) of all U.S. Class I railroads in 1976.

TABLE 6-3

MAINLINE MILEAGE OF RAILROADS OPERATING IN THE STUDY REGION

(Route Miles)

Railroad	Mainline Mileage Operated in 1976 In Study Region	 Total
Atchison, Topeka & Santa Fe	955	5,905
Bessemer & Lake Erie	120	190
Burlington Northern, Inc.	2,618	12,271
Baltimore & Ohio	1,551	4,446
Chicago & North Western	1,264	2,858
Chesapeake & Ohio	683	3,370
Conrail	2,796	6,264
Chicago & Eastern Illinois	267	615
Detroit, Toledo & Ironton	48	428
Elgin, Joliet & Eastern	46	157
Kansas City Southern	812	1,582
Monongahela	52	183
Missouri-Kansas-Texas	627	1,551
Chicago, Milwaukee, St. Paul & Pacific	1,383	3,048
Missouri Pacific	2,106	7,617
Norfolk & Western	1,310	5,627
Illinois, Central & Gulf	3,754	6,784
Louisville & Nashville	1,995	4,367
Chicago, Rock Island & Pacific	2,066	5,209
Seaboard Coast Line	263	7,686
Soo Line	446	1,458
Southern	1,839	3,859
St. Louis Southwestern	514	1,114
Southern Pacific Transportation	210	6,146
St. Louis-San Francisco	1,015	3,487
Texas & Pacific	302	1,714
Toledo, Peoria & Western	91	296
Union Pacific	520	4,861
Western Maryland	142	775
Total	29,825	103,868

Source: Schedule 411 of the Railroads' Annual Report, Interstate Commerce Commission (Form R-1).

"Financially weak roads, having uncertain short to medium range financial features."* Conrail was formed in April 1976 from seven bankrupt eastern railroads. Illinois Central Gulf also had poor financial results in recent years. In summary, a substantial portion (34 percent) of the lines in the study region were operated by financially weak railroads.

In Table 6-4, a summary of the geographical distribution of the rail lines in the study region is provided.

Condition of Track and Equipment

Railroads, unlike other modes of transportation, own and maintain the network -- namely track and roadway, over which they haul traffic. One indication of their track and equipment condition is provided by the railroads' expenses for deferred maintenance and delayed capital improvements. The following excerpts from an ICC order dated July 18, 1974 give definitions for the terms "deferred maintenance" and "delayed capital improvements."

> "For purposes of this order, deferred maintenance is defined as the accrued deterioration or deficiency in the physical operating condition of railroad track structures, cars and locomotives, and other property used in the provision of transportation service resulting from the failure and/or inability to properly maintain plant and equipment, which produces an adverse effect on railroad operations to an extent that services to shippers have been rendered partially or wholly inadequate and/or has resulted in diminishing the railroads' competitive ability;
>
> For purposes of this order, delayed capital improvements represent actually planned, specifically identified capital improvements necessary for the provision of adequate or improved transportation service to shippers and which had not been undertaken, scheduled,

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* ICC, Rail Service Planning Office, Rail Merger Study, Initial Paper, April 15, 1977, p. 29.

TABLE 6-4

GEOGRAPHICAL DISTRIBUTION OF RAIL MAINLINES IN THE STUDY REGION

	State	Route Miles	Percent of Total
1	Alabama	1,898	6.4
2	Arkansas	1,713	5.7
3	Illinois	4,682	15.7
4	Iowa	2,766	9.4
5	Kansas	1,063	3.6
6	Kentucky	1,294	4.3
7	Louisiana	1,520	5.1
8	Minnesota	1,118	3.7
9	Mississippi	1,280	4.3
10	Missouri	2,828	9.5
11	Nebraska	838	2.8
12	Ohio	2,604	8.7
13	Oklahoma	1,321	4.4
14	Pennsylvania	1,564	5.2
15	Tennessee	1,342	4.5
16	West Virginia	1,130	3.8
17	Wisconsin	864	2.9
	Total	29,825	100.0

Source: Analysis by Temple, Barker & Sloane, Inc.

Note: The study region for purposes of the railroad analysis is defined as the area covering 150 miles on either side of the river system.

> or otherwise committed because funding or financing was not, or projected to be available through June 30, 1975. They exclude improvements in progress and those scheduled or otherwise committed and recognized in capital budgets in effect or applicable on June 1, 1974. These capital improvements are further identified as delayed expenditures which would: 1) add to or improve the carriers' plant and/or equipment so as to increase its usefulness, capacity durability and efficiency, and, 2) which are capitalizable in the property accounts in accordance with the Commission's accounting regulations;"

As shown in Table 6-5, the railroads operating in the study region accounted for over 92 percent ($3.8 billion) of the $4.1 billion deferred maintenance and delayed capital improvements of all U.S. Class I railroads.*

If the $3.8 billion were distributed based on the proportion of the railroads' mainlines in the region to their system mainline miles, the deferred maintenance and delayed capital expenditures for the lines in the study region would have totalled over $1.0 billion as of 1976.

TABLE 6-5

DEFERRED MAINTENANCE AND DELAYED CAPITAL EXPENDITURES FOR RAILROADS OPERATING IN THE STUDY REGION AND U.S.

As of June 30, 1976

(thousands of dollars)

	All Class I Railroads	Railroads in Study Region	Railroads in Study Region: Share of All Railroads
Deferred Maintenance			
--Roadway	$1,345,772	$1,238,283	92%
--Equipment	200,410	168,518	84%
Delayed Capital Expenditures			
--Roadway	1,461,845	1,351,414	92%
--Equipment	1,134,119	1,044,660	92%
Total	$4,142,144	$3,802,875	92%

Source: "Ex Parte 305 Report for Second Quarter Ending June 30, 1976". ICC, Bureau of Accounts.

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* The sum $4.1 billion was more than nine times the U.S. Class I railroads' 1976 net railway operating income and was equal to 22 percent of their 1976 operating revenue.

Rail Traffic Trend

In the last several years U.S. rail traffic growth has lagged behind that of the economy. As shown in Table 6-6 between 1969 and 1976, GNP increased at an annual rate of 2.4 percent. However, the U.S. rail ton-miles and the combined traffic of the ten leading railroads in the study region grew at annual rates of 0.4 percent and 1.9 percent repectively. In contrast to the railroads, the traffic on inland waterways increased 1.3 percent annually in the same time period.

PIPELINE FACILITIES AND TRAFFIC

Over the pipeline industry's 150-year history, pipelines have been used primarily to transport energy materials, such as liquid petroleum and natural gas; with improved technologies and economic advances, pipelines are being used to transport liquefied petroleum gas (LPG), liquefied natural gas (LNG), chemicals, such as anhydrous ammonia and to a very limited extent, coal.

Pipelines transport over one-fourth of the total United States freight tonnage. As shown in Table 6-7, 440,600 miles of major intercity pipelines, existing in 1975, carried 1.9 billion tons of cargo, shipped over an average distance of 425 miles, for a total of 809 billion ton-miles. The total value of pipeline shipments exceeded $125 billion, with the actual cost of shipping placed at about $4.8 billion or approximately four percent of its value. The estimated investment in pipelines, would equal about $70 billion.

Competition between pipelines and other transport modes exists in the case of crude oil, petroleum products, coal and chemicals. Natural gas is carried exclusively by pipeline.

The Hepburn Act of 1906 placed crude oil and petroleum products pipelines under the jurisdiction of the Interstate Commerce Commission, making these pipelines regulated, common

TABLE 6-6

COMPARISON OF GNP AND RAIL TRAFFIC
(1969-1976)
(billions of dollars)

		Net Ton Miles		
	GNP (1972 $)	All U.S. Class I Railroads	Major Railroads* Operating in the Mid America Area	Domestic Waterborne Commerce in the Mid America Area
1969	1079	768	411	159.11
1970	1075	765	417	175.58
1971	1108	740	408	181.07
1972	1171	777	440	192.93
1973	1235	852	487	184.94
1974	1218	851	492	195.33
1975	1202	754	439	194.29
1976	1275	791	470	208.87
Percent Change (1969-1976)	18%	3%	14%	31%
Av. Annual Growth (1969-1976)	2.4%	0.4%	1.9%	4.0%

* Includes the ten railroads discussed in pages 1 and 2.

Sources:
1. Economic Indicators
2. Association of American Railroads, Fact Book, 1977 ed.
3. Association of American Railroads, Operating and Traffic Statistics

Temple, Barker & Sloane, Inc.

TABLE 6 - 7

MAJOR U.S. INTERCITY PIPELINE SYSTEMS AS OF 1975

Pipeline Category	Miles*	Tons of Cargo Shipped (millions)	Ton-Miles (billions)	Shipping Costs (millions of dollars)
Natural Gas	265,000	406	326	$ 3,286
Crude Oil	103,100	793	269	654
Petroleum Products	67,800	686	211	870
Coal Slurry	300	5	1	8
Chemicals	4,000	14	2	16
TOTALS	440,600	1,904	809	$ 4,834

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* Miles rounded to nearest one hundred.

Source: National Transportation Trends and Choices (To the Year 2000)
U.S. Department of Transportation, January 1977.

carriers. Natural gas pipelines are regulated by the Federal Power Commission. All U.S. pipelines are presently owned and operated by private enterprise.

The following sections review the status of the pipeline system as of 1975 by product carried.

Natural Gas

Natural gas is America's most significant domestic fuel. Five contiguous states, namely Texas, Louisiana, Oklahoma, Kansas and New Mexico produce over 90 percent of the marketed production of natural gas in the entire United States. These five states also consume approximately 30 percent of production with another 30 percent consumed in two major areas, the North Central and Middle Atlantic States and California and the remaining 40 percent consumed by the other 36 states. Alaska, Hawaii and Vermont are not included in the U.S. natural gas supply network.*

Natural gas is gathered from field-production facilities by means of systems which include compressor stations, processing stations and gas treaters. The transmission system includes mainline pipe, compressor stations, metering stations and pressure regulator facilities. Gas distribution systems are comprised of various pressure mains, pressure regulation equipment, metering equipment, odorization facilities, control instrumentation, and related maintenance and service equipment.

The total natural gas pipeline system is approximately 1.4 million miles in length, composed of some 265,400 miles of intercity transmission mains, 660,000 miles of distribution mains and 440,000 miles of service lines. In comparison to other pipelines, the natural gas system is, by far, the most extensive.

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* Source: Mineral Industry Surveys, Natural Gas Production and Consumption: 1974, Bureau of Mines, Department of Interior, 1975.

As previously mentioned, natural gas is carried almost exclusively by pipeline and is, therefore, basically noncompetitive with other modes of transportation. A very minor exception does exist, however, whereby shipment of natural gas may occur via road or waterway in special handling equipment designed to carry natural gas converted to a cryogenic liquid.

Since natural gas shipment via pipeline is essentially noncompetitive with other forms of transportation, the question may be raised as to its relevance to this study. The answer is related to the effects of the "natural gas shortage." Diminishing supplies of natural gas at the existing production fields means increasing pipeline capacity and in possible instances, retirement of a line. Under these circumstances, a gas transmission network can be modified to carry other products which are competitive with other modes of transportation. An example of this, to be covered in a later change, is a proposal to modify and reverse the direction of flow of a natural gas pipeline to carry crude oil.

Crude Oil and Petroleum Products

Crude oil and refined products provided an estimated 46 percent of the energy consumed in the United States in 1975. The Association of Oil Pipelines reports that 621 million tons of crude oil moved in domestic transportation in 1974, broken down by mode as follows:

- 464 million tons by pipeline
- 129 million tons by water carriers, including 45 million tons off-loaded by tankers at refineries
- 70 million tons by motor carriers
- 3 million by railroad.*

Of the 1,253 million tons of refined products moved in 1974, some 481 million tons were shipped via motor carrier,

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* Association of Oil Pipelines; Press Release "Oil Pipelines Continue to Lead All Other Forms of Transport in Movement of Oil in 1974," May 26,1976; 1725 K Street, N.W., Washington,DC 20006.

420 million tons by pipeline, 324 million tons via water carriers and 27 million tons via rail.* Gas liquids, in 1975, moved predominantly by pipeline, accounting for 94 percent of total shipments. Of the 94 percent, 91 percent was ultimately transshipped via motor carrier; two percent via rail; and, about one percent via barge. Motor carrier and rail movements are primarily short collection and distribution hauls and, accordingly, only four percent moved solely by motor carrier and two percent solely by rail.**

As with the production of natural gas, the five contiguous states of Texas, Louisiana, Oklahoma, Kansas and New Mexico lead in the production of crude oil, accounting for 69 percent of all domestic production.*** Texas, California, Louisiana and Illinois led in refining, followed by the Great Lakes and Middle Atlantic regions (Indiana, Ohio, Pennsylvania and New Jersey). Most other states had refined products productions. The production of natural gas liquids (LNG) parallels the natural gas production breakdown while production of petroleum gas liquids (LPG) parallels the refined products production breakdown.

Generally speaking, the major direction of the movements of crude oil, petroleum and gas liquids is north and east from the Gulf region towards major industrial and population centers. The basic pattern of movement for crude oil is via pipeline within and from the southwestern states to the Great Lakes and Middle Atlantic refineries. Refined products produced in the Great Lakes and Middle Atlantic States are generally consumed in this region but there are also significant exports. Major movement patterns are evident from the southwestern region to the central states and eastern seaboard. Major flow patterns of gas liquids are noted within the south/southwestern states and the central states with a significant pattern of movement from the southwestern region to the central states and eastern seaboard. Figure 10a, 1975 Pipeline Transfers of Crude Oil, Petroleum Products and Natural and Synthetic Gas depicts these patterns for the energy consumption and transfers between the five Petroleum Administration for Defense Districts (PADD's).

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* Ibid., Table 3.

** National LP-Gas Association; 1975 LP-Gas Market Facts, p.9; 79 West Monroe Street, Chicago, Illinois 60603.

*** American Petroleum Institute and American Gas Association; Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States, as of December 31, 1974, p. 23.

Crude oil pipelines carry oil from lease tanks, flow lines and oil-gathering systems through a trunkline system to refineries. Petroleum product pipelines carry such commodities as gasoline, jet fuel, fuel oil, LPG and LNG from the refineries or gas processing plants to bulk terminals, storage and distribution points and/or directly to major consumers.

Trunk pipelines for crude oil and petroleum products totalled some 171,000 miles in 1975. In addition, there were some 70,000 miles of gathering pipelines which bring crude oil from fields and wells to common points for storage, refining or trunk pipeline transportation.

Figure 10b, 1975 Crude Oil and Petroleum Product Pipeline Capacities show major pipeline corridors between and within the PADD's and the number shown for each corridor represents capacity in thousand of barrels per day. The south and central designated PADD's lie within the tributary area of the waterways being analyzed in this study. Therefore, it is appropriate to examine pipeline transfers and capacities between these two districts.

Figure 10a shows that 1,485,000 barrels per day of domestic crude oil and 119,000 barrels per day of foreign crude oil moves north from the South to the Central district. The corresponding pipeline capacity, from Figure 10b,is 2,654,000 barrels per day, indicating that a capacity reserve, operating at maximum throughput potential, of approximately one million barrels per day or some 40 percent is available. A similar examination of petroleum products shows pipeline transfers from south to central at 478,000 barrels per day versus a capacity of 774,000 barrels per day thus indicating a capacity reserve of also some 40 percent. The predominant flow of petroleum products from south to east shows transfers of some 1,630,000 barrels per day versus a capacity of 2,089,000 barrels per day. A capacity reserve of some 22 percent is evident.

Expansion of the present pipeline system for crude oil and petroleum products, including gas liquids, will be based primarily on production sources external to the contiguous 48 states. A discussion of new pipeline proposals is covered in Chapter 10.

Chemicals

The approximately 4,000 miles of chemical pipeline in the United States are used to transport anhydrous (liquid) ammonia, ethylene and propylene. The 4,000 miles of chemical pipeline are comprised of the three following systems:

1. An 850-mile anhydrous ammonia line from Texas to Iowa;
2. A 1,100-mile ammonia line from Louisiana to Nebraska; and
3. A 2,100-mile system which connects a series of ethylene/propylene producing and consuming plants along the Gulf Coast from Freeport, Texas to Plaquemine, Louisiana.

Coal Slurry

A coal slurry system actually consists of three major components, each in itself a sophisticated plant facility. The components are broken down into the slurry preparation plant, the transmission pipeline and the solids-dewatering facility. Slurry preparation consists of crushing the solids to an appropriate size, mixing the particles with an appropriate amount of water and treating the water to prevent corrosion of the pipeline and to produce good flow and final separation. The pipeline consists of storage facilities and pumping stations. Dewatering facilities include storage tanks, screens, filters, centrifuges, thermal dryers and water treatment facilities.

Up until this time, only two coal slurry pipelines were built in the United States. One of the lines, a 10-inch diameter, 108-mile long pipeline runs from Cadiz to Cleveland, Ohio. It was constructed in 1957 and operated only six years before ceasing operations due to competition from the railroads. The introduction of coal unit trains with their correspondingly lower tariffs made this line non-competitive.

The second line, known as the Black Mesa line was constructed in 1970. It is 273 miles long, has an 18-inch diameter and a capacity for moving some five million tons per year. It is still operating.

The future of coal as a prime energy source and its method of transportation is a subject of intense current interest. Chapter 10 presents coal slurry pipeline proposals and discusses the many issues concerning their construction feasibility.

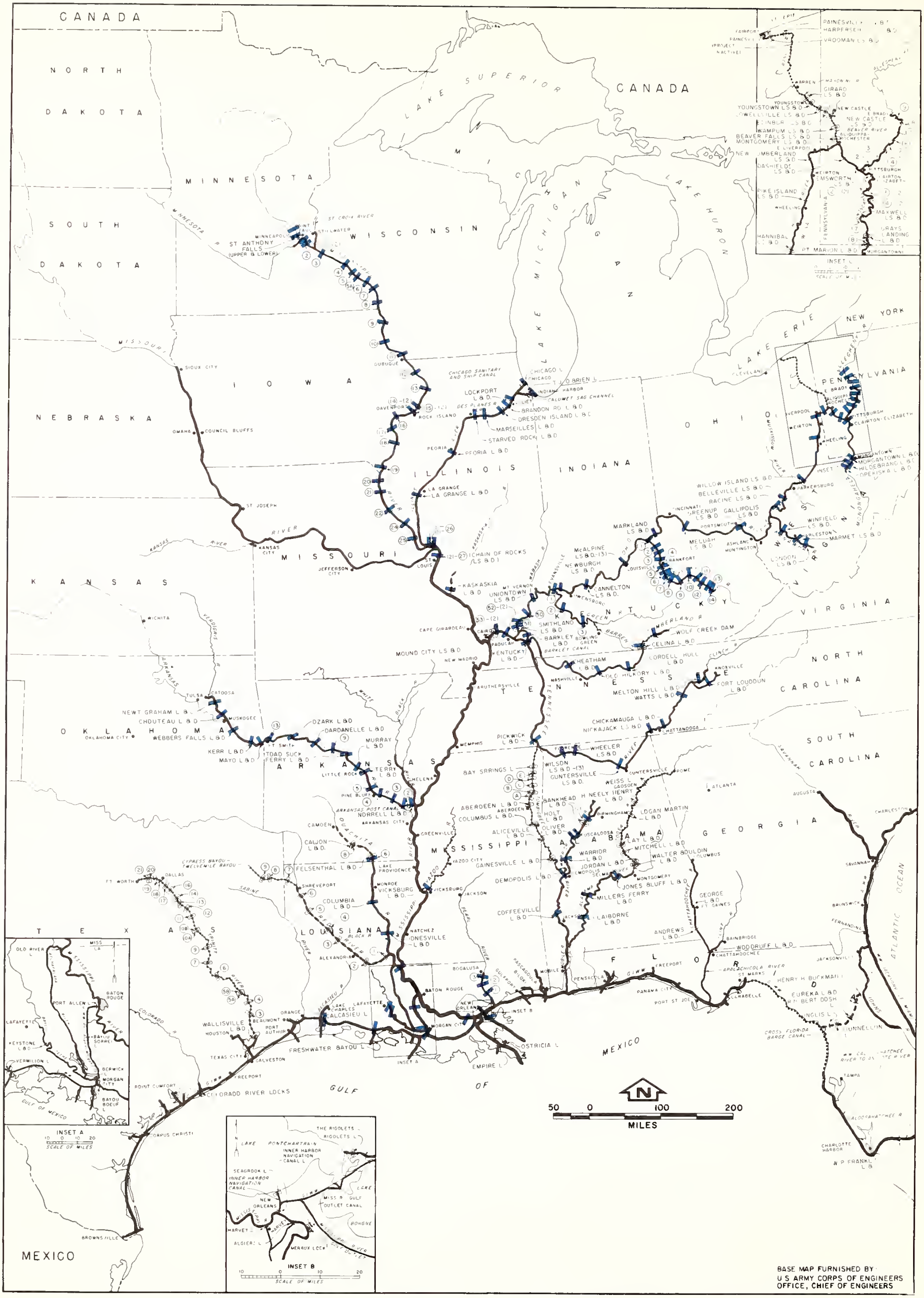
CANADA
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
WISCONSIN
LAKE SUPERIOR
MICHIGAN
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
NEW YORK
PENNSYLVANIA
OHIO
INDIANA
ILLINOIS
IOWA
NEBRASKA
KANSAS
MISSOURI
OKLAHOMA
ARKANSAS
TEXAS
LOUISIANA
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
TENNESSEE
KENTUCKY
WEST VIRGINIA
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
ATLANTIC OCEAN
GULF OF MEXICO
MEXICO
MINNEAPOLIS
ST ANTHONY FALLS (UPPER & LOWER)
ST CROIX RIVER
STILLWATER
MINNESOTA R
DUBUQUE
DAVENPORT
ROCK ISLAND
SIOUX CITY
OMAHA
COUNCIL BLUFFS
ST JOSEPH
KANSAS CITY
JEFFERSON CITY
MISSOURI RIVER
KANSAS RIVER
ST LOUIS
CHAIN OF ROCKS L S & D
CHICAGO SANITARY AND SHIP CANAL
CHICAGO
T J O'BRIEN L
INDIANA HARBOR
CALUMET SAG CHANNEL
LOCKPORT L & D
JOLIET
DES PLAINES R
BRANDON RD L & D
DRESDEN ISLAND L & D
MARSEILLES L & D
STARVED ROCK L & D
PEORIA
PEORIA L & D
LA GRANGE
LA GRANGE L & D
KASKASKIA
KASKASKIA L & D
MT VERNON
UNIONTOWN LS & D
CAPE GIRARDEAU
CAIRO
MOUND CITY LS & D
NEW MADRID
PADUCAH
SMITHLAND LS & D
BARKLEY L & D
BARKLEY CANAL
KENTUCKY L & D
BOWLING GREEN
GREEN
BARREN
CANNELTON LS & D
OWENSBORO
NEWBURGH LS & D
EVANSVILLE
McALPINE LS & D
LOUISVILLE
FRANKFORT
MARKLAND L & D
CINCINNATI
GREENUP L & D
GALLIPOLIS L & D
MELDAHL L & D
PORTSMOUTH
ASHLAND
HUNTINGTON
LONDON LS & D
WINFIELD LS & D
CHARLESTON
MARMET LS & D
RACINE LS & D
BELLEVILLE LS & D
WILLOW ISLAND LS & D
PARKERSBURG
MORGANTOWN
MORGANTOWN L & D
HILDEBRAND L & D
OPEKISKA L & D
WHEELING
WEIRTON
LIVERPOOL
PITTSBURGH
CLAIRTON-ELIZABETH
E BRADY
ALLEGHENY R
MONONGAHELA
MUSKINGUM R
CLEVELAND
INSET
CUMBERLAND R
WOLF CREEK DAM
CELINA L & D
CORDELL HULL L & D
OLD HICKORY L & D
CHEATHAM L & D
NASHVILLE
KNOXVILLE
FORT LOUDOUN L & D
MELTON HILL L & D
WATTS L & D
CHICKAMAUGA L & D
NICKAJACK LS & D
CHATTANOOGA
PICKWICK L & D
FLORENCE
WHEELER L & D
WILSON L & D -(3)
GUNTERSVILLE L & D
GUNTERSVILLE
TENNESSEE RIVER
MEMPHIS
CARUTHERSVILLE
HELENA
TULSA
CATOOSA
NEWT GRAHAM L & D
CHOUTEAU L & D
MUSKOGEE
WEBBERS FALLS L & D
OKLAHOMA CITY
WICHITA
VERDIGRIS R
ARKANSAS R
KERR L & D
MAYO L & D
FT SMITH
TOAD SUCK FERRY L & D
OZARK L & D
DARDANELLE L & D
MURRAY L & D
TERRY L & D
LITTLE ROCK
PINE BLUFF
ARKANSAS POST CANAL
NORRELL L & D
ARKANSAS CITY
CAMDEN
CALION L & D
FELSENTHAL L & D
OUACHITA R
LAKE PROVIDENCE
MONROE
COLUMBIA L & D
SHREVEPORT
RED RIVER
ALEXANDRIA
BLACK R
JONESVILLE L & D
NATCHEZ
VICKSBURG
VICKSBURG L & D
YAZOO R
YAZOO CITY
GREENVILLE
JACKSON
PEARL R
BOGALUSA
BATON ROUGE
NEW ORLEANS
MORGAN CITY
OSTRICIA L
EMPIRE L
INSET A
INSET B
LAKE CHARLES
CALCASIEU L
LAFAYETTE
FRESHWATER BAYOU L
ORANGE
BEAUMONT
PORT ARTHUR
WALLISVILLE L & D
HOUSTON
TEXAS CITY
GALVESTON
FREEPORT
POINT COMFORT
COLORADO RIVER LOCKS
CORPUS CHRISTI
BROWNSVILLE
DALLAS
FT WORTH
TRINITY R
SABINE
COLORADO R
CYPRESS BAYOU-TWELVEMILE BAYOU
BAY SPRINGS L
ABERDEEN L & D
ABERDEEN
COLUMBUS L & D
ALICEVILLE L & D
GAINESVILLE L & D
DEMOPOLIS L & D
COFFEEVILLE L & D
BANKHEAD L & D
HOLT L & D
OLIVER L & D
TUSCALOOSA
WARRIOR L & D
H NEELY HENRY L & D
WEISS L
GADSDEN
ROME
BIRMINGHAM
LOGAN MARTIN L & D
LAY L & D
MITCHELL L & D
JORDAN L & D
WALTER BOULDIN
MONTGOMERY
JONES BLUFF L & D
MILLERS FERRY L & D
SELMA
CLAIBORNE L & D
MOBILE
PASCAGOULA R
GULFPORT
BILOXI
PENSACOLA
PANAMA CITY
PORT ST JOE
GIWW
ATLANTA
GEORGE L & D
FT GAINES
COLUMBUS
ANDREWS L & D
BAINBRIDGE
WOODRUFF L & D
CHATTAHOOCHEE
APALACHICOLA RIVER
ST MARKS
CARABELLE
AUGUSTA
SAVANNAH R
SAVANNAH
CHARLESTON
BRUNSWICK
FERNANDINA
JACKSONVILLE
HENRY H BUCKMAN L
EUREKA L & D
RODMAN DAM
INGLIS L
DUNNELLON
CROSS FLORIDA BARGE CANAL
TAMPA
CALOOSAHATCHEE R
CHARLOTTE HARBOR
W P FRANKLIN L & D
ST JOHNS
PAINESVILLE
HARPERSFIELD
VROOMAN
FAIRPORT
GIRARD LS & D
YOUNGSTOWN
YOUNGSTOWN LS & D
LOWELLVILLE LS & D
EDINBURG LS & D
WAMPUM LS & D
BEAVER FALLS LS & D
MONTGOMERY L & D
NEW CUMBERLAND L & D
DASHIELDS L & D
NEW CASTLE
BEAVER RIVER
ALIQUIPPA
ROCHESTER
E LIVERPOOL
PIKE ISLAND L & D
EMSWORTH L & D
MAXWELL L & D
GRAYS LANDING L & D
HANNIBAL L & D
PT MARION L & D
WARREN
PENNSYLVANIA
OHIO
INSET
SCALE OF MILES
OLD RIVER L
PORT ALLEN L
BAYOU SORREL L
KEYSTONE L & D
VERMILION L
BERWICK
MORGAN CITY
BAYOU BOEUF L
INSET A
10 0 10 20
SCALE OF MILES
THE RIGOLETS
RIGOLETS L
LAKE PONTCHARTRAIN
INNER HARBOR NAVIGATION CANAL L
SEABROOK L
INNER HARBOR NAVIGATION CANAL
NEW ORLEANS
MISS R GULF OUTLET CANAL
LAKE BORGNE
HARVEY L
ALGIERS L
EMPIRE LOCK
INSET B
10 0 10 20
SCALE OF MILES
N
50 0 100 200
MILES
BASE MAP FURNISHED BY
U S ARMY CORPS OF ENGINEERS
OFFICE, CHIEF OF ENGINEERS

FIGURE 9 EXISTING LOCKS AND DAMS

CHAPTER 7

SHIPPING TECHNOLOGY

This chapter describes the existing fleets and current technology of vessels serving the inland waterways.* Four vessel types are considered: towboats, barges, barge carriers and mini-ships.

THE TOWBOAT FLEET

There are 2,500 line-haul towboats propelling more than 20,000 barges between ports on the inland waterways system.

Towboats on the waterways may be divided into three categories, each of which has unique requirements:

- Workboats and fleetboats -- low horsepower vessels designed to handle and sort barges alongside terminals, to transport barges to and from fleet areas and to break-off or add-on barges to line-haul tows moving in midstream. Crew accommodations are minimal and power ranges up to 1,500 hp. Approximately 1,100 craft served inland waterways ports, terminals, and fleeting areas in 1975.

- Line-haul towboats -- medium horsepower towboats with single or twin screws that handle the majority of multi-barge tows on all rivers in the inland waterways system. About 1,200 towboats operated on the Mississippi-Gulf Intracoastal Systems in 1975. Line-haul boats frequently "turn-around" in the Cairo area, transferring barges to and from higher horsepower towboats working the Lower Mississippi.

- Lower Mississippi and Ohio River line-haul towboats -- high horsepower towboats with twin or triple screws move the largest tows in the relatively broad reaches of the inland waterway network.* Approximately 40 towboats were in operation in 1975.

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* Appendix C contains a more comprehensive discussion of inland waterway fleet technology.

Table 7-1 presents the 1975 towboat fleet serving interport inland navigation in the Mid-America area.

TOWBOAT TECHNOLOGY

Efficiency in towboat operations has been largely realized through the construction of increasingly powerful line-haul and shift towboats within smaller, lighter and more durable hull and deckhouse envelopes. At the same time, diesel engines have become more compact and powerful. Figure 11 graphically presents the more than 40 percent increase in towboat horsepower per gross ton delivered that has been achieved since 1950.** This development has been furthered by vessel streamlining and mechanical refinements.

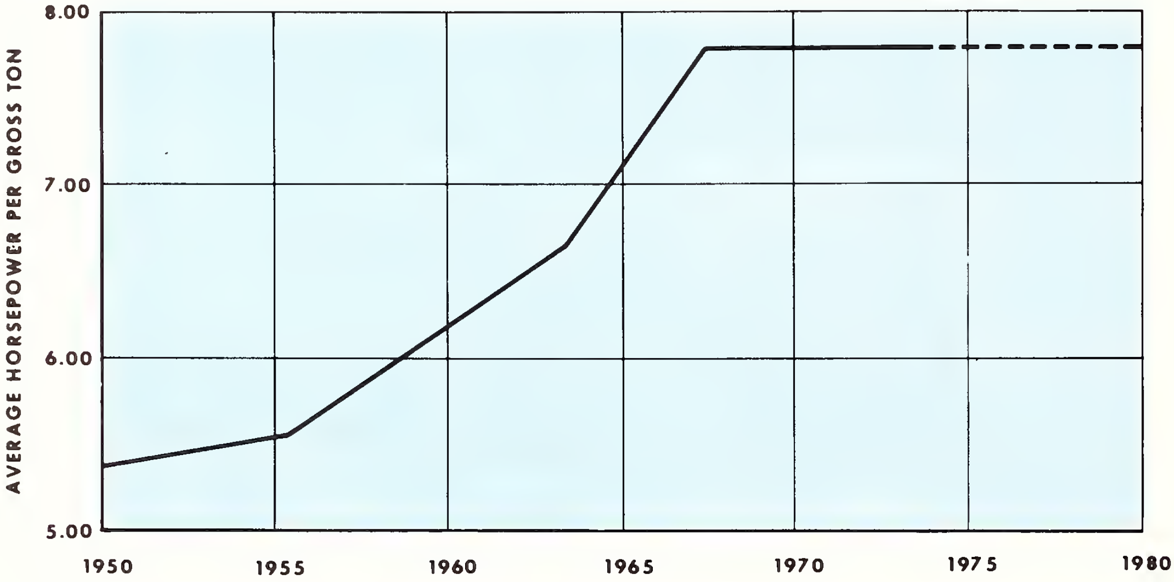

FIGURE 11 - TOWBOATS DELIVERED
AVERAGE HORSEPOWER INSTALLED PER GROSS TON

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* In 1977, year-end grain shipments attracted 10,500 horsepower towboats to points as far north as L/D 21 on the upper Mississippi.

** Gross tonnage is a cubic measurement of the gross volume enclosed by a vessel, including hull, superstructure, and deckhouses. 100 cubic feet equals 1 gross ton.

TABLE 7-1

COMPOSITION OF THE MISSISSIPPI AND GULF INTRACOASTAL WATERWAY* INTERPORT TOWBOAT FLEET

1975

Towboat Class (HP)	Number of Towboats	Average (feet)			Maximum Practical Tow Size**
		Length	Breadth	Draft	
300	150	46	15	4.2	2
600	250	57	18	5.1	4
1,200	500	78	23	6.9	8
1,800	103	110	29	8.6	12
2,500	52	131	33	9.5	14
3,300	88	146	34	8.8	17
4,300	49	146	37	9.5	23
5,000	36	150	40	9.4	26
5,700	32	160	45	9.4	28
7,000	22	175	50	9.0	33
8,400	11	180	52	9.2	36
9,000	2	182	58	8.6	38
10,100	4	190	54	9.0	40
2,278,700	1,299				

*Towboats engaged in inter-port transportation.

**195 x 35-foot barges.

Source: CACI, Inland Navigation Simulation Model (INSA), Army Corps of Engineers.

Triple screw towboats of over 10,000 horsepower are currently in operation on the Lower Mississippi. These powerful vessels have been developed in response to two developments: large tows; and high midstream current velocities induced by Corps of Engineers channel-depth improvements. Operational difficulties including lock restrictions discussed in Chapter 11 discourage the use of triple-screw boats on narrow reaches of the waterways.

Using tunnelled sterns, 10-foot diameter ducted (nozzle) propellers are now commonly operating in 9- and 10-foot channel depths. Propeller immersion is maintained through the use of ballast tanks which compensate for fuel and lubricant consumption.

Navigational aids have expanded from simple watermarks and river charts, augmented 50 years ago by wireless and later by radio telephone, to an assortment of sophisticated instrumentation including autopilots, teletype and telex printed information transfer, depth finders, turnometers or "swing indicators," and true motion radar.

Towboat machinery installations are now monitored by sensory systems that display and record operating conditions at up to 50 points in main and auxiliary machinery systems. A reduction of engineering staff has been permitted as a consequence.

The deck department of towboats has not been so easily trimmed as its engine room counterpart. Handling large tows moving at high speeds still requires human judgment and attention to the composition of each tow. Despite the use of improved ratchets and hydraulic and air-powered winches aboard towboats to tighten security wires and backing lines, the assembly of a large tow is an arduous and time-consuming task.

Towboat complements typically comprise 6 to 11 crew members. A substantial reduction in crew size has been achieved since the 1940's, predominantly in engine department officers. Enhanced crew productivity has been complemented by high vessel productivity. Midstream provisioning and efficient maintenance procedures have permitted line-haul towboats to reduce annual days lost to less than two percent.

The use of bow boats to assist in the steering and maneuvering of large tows is several decades old, but only since 1964 have small radio-remote controlled bow boats, incorporating a diesel plant and 360° ducted steering propellers, come into use. Bow boats augment towboat thrust and swinging power at the direction of the towboat pilot and offer better tow control, better stopping power, additional line-haul thrust, and use as a standby fleeting vessel or shuttle unit at terminals.

THE BARGE FLEET

More than 20,000 barges serve the Mississippi River system and the Gulf Intracoastal Waterway, carrying the full range of inland waterborne movements.

The barge types and technology that have evolved to serve the demand for waterway navigation reflect the composition of the cargoes. In 1975 more than 75 percent of all short-ton internal and local traffic in the Mid-America area consisted of only nine of the 175 SSCC commodities. Table 7-2 presents these nine commodities and the barge types most frequently used to transport these commodities. Table 7-3 summarizes the more than 17,000 barges deployed on the Mississippi and Gulf Intracoastal Waterway in 1975 that engaged in transportation services.

BARGE TECHNOLOGY

Since 1950, the average deadweight of all delivered barges has increased from 1,265 to 1,410 short tons, and a very substantial share of this increase has been realized on the inland waterways. Table 7-4 traces the numbers of tank and dry cargo non-self propelled vessels operating on the Mississippi River system and Gulf Intracoastal Waterway 1968-1975.

TABLE 7-2

LEADING COMMODITIES AND BARGE TYPES

Commodity Code	Commodity Name	Percent of Total Tons*	Barge Type(s)
1121	Coal and lignite	35.1	Open Hopper
1442	Sand, gravel, crushed rock	9.1	Open Hopper
1311	Crude petroleum	6.6	Tank
2911	Gasoline	6.3	Tank
0103	Corn	6.1	Covered Hopper
2915	Residual fuel oil	4.2	Tank
2914	Distillate fuel oil	3.1	Tank
2819	Basic chemicals and products, NEC	2.9	Tank
4118	Waterways Improvement Materials	2.6	Open Hopper/Deck
Total		76.0%	

*Percent of 1975 short ton internal and local traffic on the main channels and tributaries of the Mississippi, Illinois, Missouri, and Ohio Rivers.

Source: Army Corps of Engineers, Waterborne Commerce of the United States, Part 2, Calendar Year 1975.

TABLE 7-3

MISSISSIPPI RIVER SYSTEM AND GULF INTRACOASTAL WATERWAY BARGE FLEET*

1975

Barge Type	Description	Number of Barges	Length & Breadth	Capacity Net Tons
Hopper	Open	204	245x35	2,400
Hopper	Open Jumbo	4,576	195x35	1,700
Hopper	Open Standard	2,408	175x26	1,060
Hopper	Open Small	977	120x30	630
Hopper	Covered Jumbo	3,861	195x35	1,700
Deck	200'	290	200x50	2,050
Deck	Jumbo	430	195x35	1,500
Deck	150'	677	150x32	600
Deck	Small--100'	1,030	100x26	350
Tank	290'	551	290x53	3,740
Tank	240'	727	240x50	3,000
Tank	185'	310	185x54	2,530
Tank	Jumbo	753	195x35	1,700
Tank	Small	440	135x40	1,300
Subtotal *		17,234		26,884,830
Other Barges, not listed**		3,794		1,665,456
Total		21,028		28,550,286

*Source: Transportation Lines of the United States, Series 4 as presented in the CACI Inland Navigation Simulation Model (INSA), Army Corps of Engineers.

**Includes dredging, construction, contractor, laid up, and idle barges.

TABLE 7-4

MISSISSIPPI RIVER SYSTEM AND GULF INTRACOASTAL WATERWAY BARGE FLEET

Year End 1968-1975

	1968	1969	1970	1971	1972	1973	1974	1975
Dry Cargo Barges and Scows								
Number of Vessels	12,056	12,550	13,318	13,985	14,904	15,765	17,345	18,049
Cargo Capacity (net tons)	13,508,798	14,284,009	14,863,812	15,934,718	17,293,167	18,583,511	21,031,652	22,255,050
Average Capacity	1,120	1,138	1,116	1,139	1,160	1,178	1,212	1,233
Tank Barges								
Number of Vessels	2,480	2,657	2,581	2,788	2,697	2,751	2,903	2,979
Cargo Capacity (net tons)	5,678,991	4,821,062	4,753,480	5,591,111	5,841,980	5,653,353	6,117,768	6,295,236
Average Capacity	2,290	1,814	1,842	2,005	2,166	2,055	2,107	2,113
Total Nonself Propelled								
Number of Vessels	14,536	15,207	15,899	16,733	17,601	18,516	20,248	21,028
Cargo Capacity (net tons)	19,187,789	19,105,071	19,617,292	21,525,829	22,775,147	24,236,864	27,149,420	28,550,286
Average Capacity	1,320	1,256	1,233	1,286	1,293	1,308	1,340	1,358

Source: Army Corps of Engineers.

Barges of all types have increased in efficiency during recent decades, through improved cargo handling and fleet management techniques and through improvements in shipping technology. The latter have taken four distinct forms:

- Increased controlling depths;
- Improved barge hydrodynamics;
- Improved barge construction; and,
- Specialized barge design.

The increase in controlling depths throughout waterway mainstreams has permitted existing barges to be consistently loaded to deeper drafts and larger barges to be designed. Third generation 250 x 52-½ foot barges permit reduction of loading, shifting, fleeting and make-up times that range up to 50 percent, and can carry an additional 350 tons of cargo with each foot of increased controlling channel depth.

Barge hydrodynamics has been an area of interest to designers since the early 1930's. Today barges incorporate raked bows, bilge radii and sterns designed to reduce drag and increase directional stability. The increased operation of unit tows of bulk commodities has fostered the use of integrated barge tows consisting of leading bow-rake barges and following box barges loaded to a uniform draft. The construction of standardized barges with eight-foot nine-inch drafts and 26, 35 and 50-foot beams is a less dramatic, but equally important, hydrodynamic improvement that serves to minimize towboat power requirements and transportation costs.

Improved barge construction through improved materials, coatings, and fabrication technologies has reduced barge maintenance requirements. Better structural design has reduced barge light ship (tare) weights, increasing displacement available for barge cargo.

The current direction of barge design is toward comprehensive system compatability between terminal technology and barge design. In recent years barges dedicated to the major commodity groups (coal, petroleums and chemicals, aggregates and agricultural products) have appeared. Specialized designs have thus permitted reduced barge turnaround and down times.

BARGE CARRIERS

The barge-carrying ship concept (Lighter Aboard Ship) in international trade is less than one decade old and remains almost exclusively a United States Gulf Coast mode of transport. Cargo markets that have been successfully penetrated by barge carriers and are consistent with the intended market include grains, rice, paper, pulp, lumber, textiles, non-ferrous ores, scrap and electric machinery.

The barge carrier concept has been realized in two forms, both consisting of a high-speed self-sustaining mother ship and an inventory of standard barges (Table 7-5). The prototype and more prolific class, LASH (Lighter Aboard Ship), employs 370 deadweight ton barges sized to be adaptable to European inland waterways. However, LASH barges are not popular with American waterway operators because of their nonstandard dimensions. Its successor, SeaBee, utilizes larger barges of 850 tons deadweight, dimensioned for maximum compatibility with the 195 x 35-foot standard jumbo barge used on America's inland waterways.* LASH and SeaBee barge carriers achieve effective loading/discharge rates of three and two barges per hour, respectively, reducing port calls to two days or less.

The fleet of barge carriers serving the U.S. Gulf Coast and the world was largely constructed in the early 1970's. Table 7-6 presents the barge-carrying fleet serving the U.S. Gulf Coast in 1978. Four Pacific Far East Lines' LASH vessels are presently being converted to full containership.

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* LASH carriers lift barges with a gantry crane, while SeaBee carriers utilize a platform elevator and deck rollers to transfer barges.

TABLE 7-5

CHARACTERISTICS OF LASH AND SEABEE BARGES

	LASH	SEABEE
Overall Dimensions:		
Length	61' 6"	97' 6"
Beam	31' 2"	35' 0"
Depth	12' 0"	12' 6"
Draft	8' 6"	
Internal Dimensions:		
Length	59' 9"	90' 0"
Width	29' 5"	30' 3"
Depth of Hold	10' 2"	14' 6"
Capacities:	19,900 ft.^{3} 370 long tons	39,140 ft.^{3} 830 long tons
Additional Characteristics		
Hatch Covers	44'x26' Liftoff	84' x 30'3"
Hull Construction	Steel	Steel
Lightweight	83 long ton	135 long tons
Total in U.S. Inventory 12/75	3,110*	246

*In 1977 802 Pacific Far East Line LASH barges were offered for sale worldwide for a variety of uses. This will reduce the U.S. inventory significantly.

Source: MarAd, *Inventory of American Intermodal Equipment*, 1976.

TABLE 7-6

BARGE CARRIERS SERVING U.S. PORTS IN 1978

Owner	Name	Flag	Dwt	Barge Capacity	Year Built	Principal Coast	Foreign Service Area
Central Gulf	Green Harbor	U.S.	46.2	89	1974	Gulf	Persian Gulf
	Green Valley	U.S.	46.2	89	1974	Gulf	Persian Gulf
	Green Island	U.S.	46.2	89	1974	Gulf	Persian Gulf
	Lash Atlantico	U.S.	29.8	77	1974	Gulf	Persian Gulf
Prudential	Lash Italia	U.S.	30.2	77	1970	Atlantic	S. America
	Lash Pacifico	U.S.	30.2	77	1972	Atlantic	S. America
Delta Steamship	Delta Mar	U.S.	40.7	70	1973	Gulf	S. America
	Delta Norte	U.S.	40.7	70	1973	Gulf	S. America
	Delta Sud	U.S.	40.7	70	1973	Gulf	S. America
Farrell Lines	Austral Moon	U.S.	29.7	77	1973	Atlantic	Africa
	Austral Rainbow	U.S.	29.7	77	1972	Atlantic	Africa
	Austral Lightning	U.S.	29.7	77	1971	Atlantic	Africa
Waterman	Robert E. Lee	U.S.	40.9	89	1974	Gulf	Persian Gulf
	Sam Houston	U.S.	40.9	89	1974	Gulf	Persian Gulf
	Stonewall Jackson	U.S.	40.9	89	1974	Gult	Persian Gulf
COMBI	Munchen	For.	44.8	80	1972	Gulf	Europe
	Bilderdyk	For.	44.8	80	1972	Gulf	Europe
Lykes Lines *	Almeria Lykes	U.S.	38.4	38	1972	Gulf	Europe
	Doctor Lykes	U.S.	38.4	38	1972	Gulf	Europe
	Tillie Lykes	U.S.	38.4	38	1973	Gulf	Europe

*SEABEE barge carriers.

Source: MarAd, Inventory of American Intermodal Equipment, 1976.

THE MINI FLEET

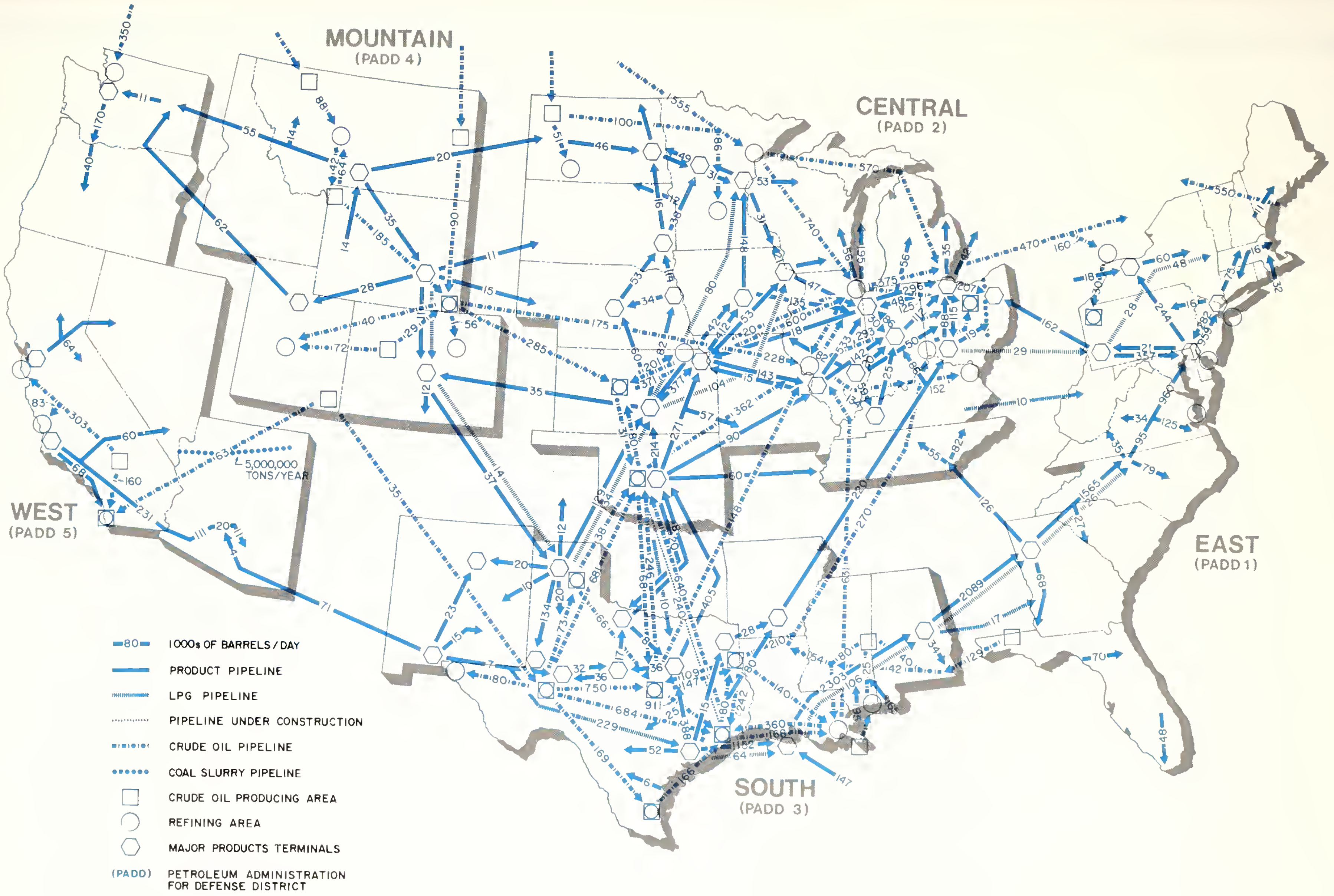
In the late 1960's, a Greek-owned fleet of small general cargo vessels commenced a service from the Gulf Coast to South America, West Africa and the Canal Zone from waterway terminals as far inland as Nashville. The standardized mini-ships were constructed in Japan expressly for navigation on inland waterways and short-sea routes. The fleet circumvents the transshipment costs and delays at downstream ports that cargoes destined or received from foreign ports close to the U.S. Gulf would have incurred. Although this fleet engaged in less than .5 percent of Mississippi River foreign trade, its competitiveness as a foreign-flag alternative to the costs of highly efficient towboat/barge and transshipment operations of the waterways is an interesting alternative. Details of vessels in the mini-fleet appear in Table 7-7.

TABLE 7 -7

THE MINI FLEET
TYPICAL VESSEL CHARACTERISTICS

Length Overall:	215 feet (65.5m)
Length Between Perpendiculars:	206 feet (62.8m)
Breadth, Extreme	50.3 feet (15.3m)
Breadth, Molded	50.1 feet (15.3m)
Draft, Maximum	16.2 feet (4.95m)
Depth	21.7 feet (6.6m)
Deadweight	3,217 tons
Gross Tonnage	1,572 tons
Grain Cubic	3,785 m^3
Bale Cubic	3,669 m^3
Twin Diesels	2,000 hp - 10.25 knots
Twin Steel Hatches	14.6m x 7.7m (47.9'x25')
Twin Holds	21.3 and 21.9m long (69.9' and 71.8')
Cranes	1 - 8 ton 2 - 15 ton

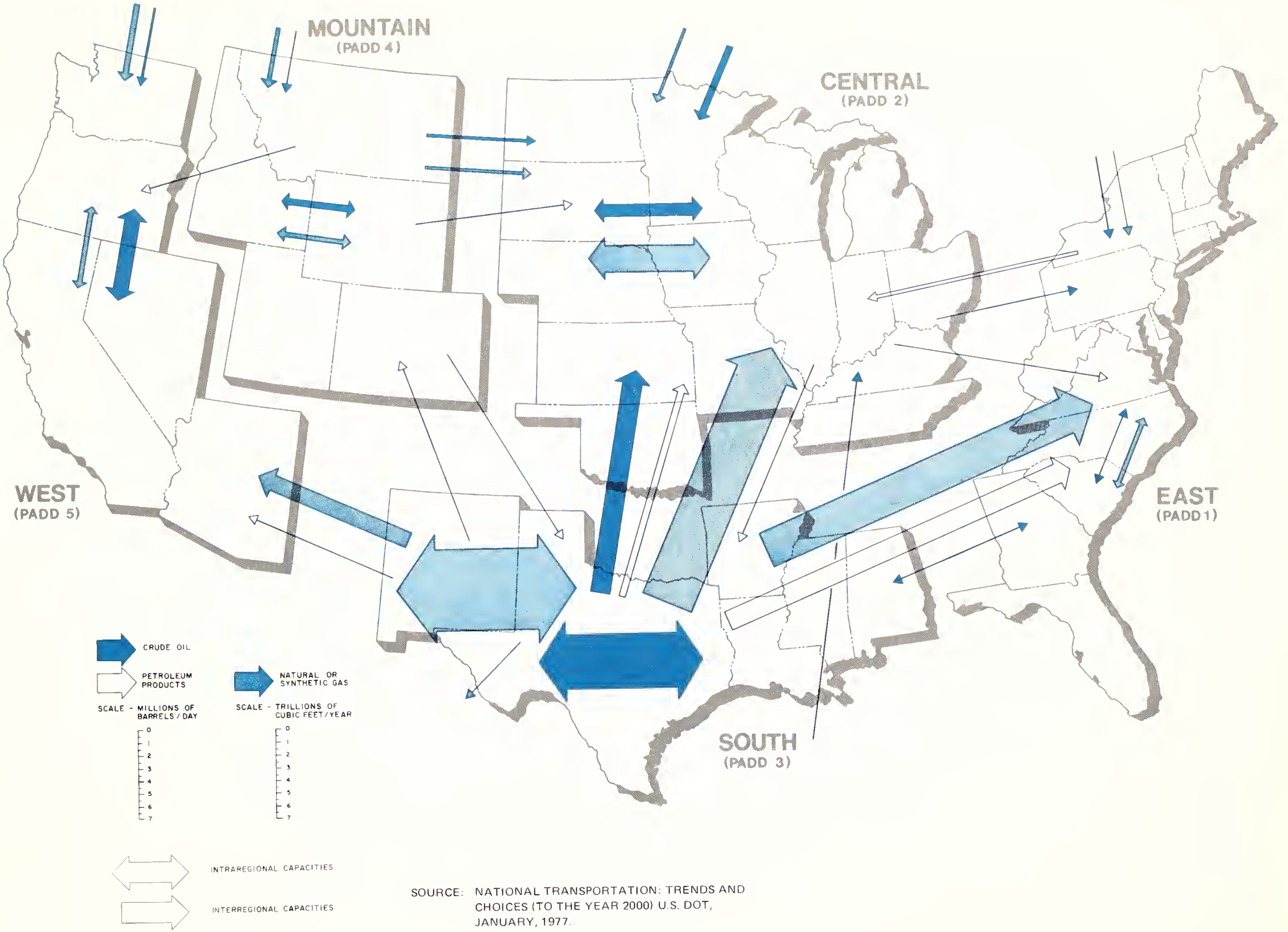
Source: Lloyds Register of Shipping, 1976.


MOUNTAIN
(PADD 4)
CENTRAL
(PADD 2)
WEST
(PADD 5)
EAST
(PADD 1)
SOUTH
(PADD 3)
5,000,000 TONS/YEAR
80 1000s OF BARRELS / DAY
PRODUCT PIPELINE
LPG PIPELINE
PIPELINE UNDER CONSTRUCTION
CRUDE OIL PIPELINE
COAL SLURRY PIPELINE
CRUDE OIL PRODUCING AREA
REFINING AREA
MAJOR PRODUCTS TERMINALS
(PADD) PETROLEUM ADMINISTRATION FOR DEFENSE DISTRICT

SOURCE: NATIONAL TRANSPORTATION: TRENDS AND CHOICES (TO THE YEAR 2000) U.S. DOT, JANUARY, 1977.

TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 10 A 1975 PIPELINE TRANSFERS


MOUNTAIN
(PADD 4)
CENTRAL
(PADD 2)
WEST
(PADD 5)
EAST
(PADD 1)
SOUTH
(PADD 3)
CRUDE OIL
PETROLEUM PRODUCTS
NATURAL OR SYNTHETIC GAS
SCALE - MILLIONS OF BARRELS / DAY
0
1
2
3
4
5
6
7
SCALE - TRILLIONS OF CUBIC FEET/YEAR
0
1
2
3
4
5
6
7
INTRAREGIONAL CAPACITIES
INTERREGIONAL CAPACITIES

SOURCE: NATIONAL TRANSPORTATION: TRENDS AND CHOICES (TO THE YEAR 2000) U.S. DOT, JANUARY, 1977.

FIGURE 10 B 1975 PIPELINE CAPACITIES

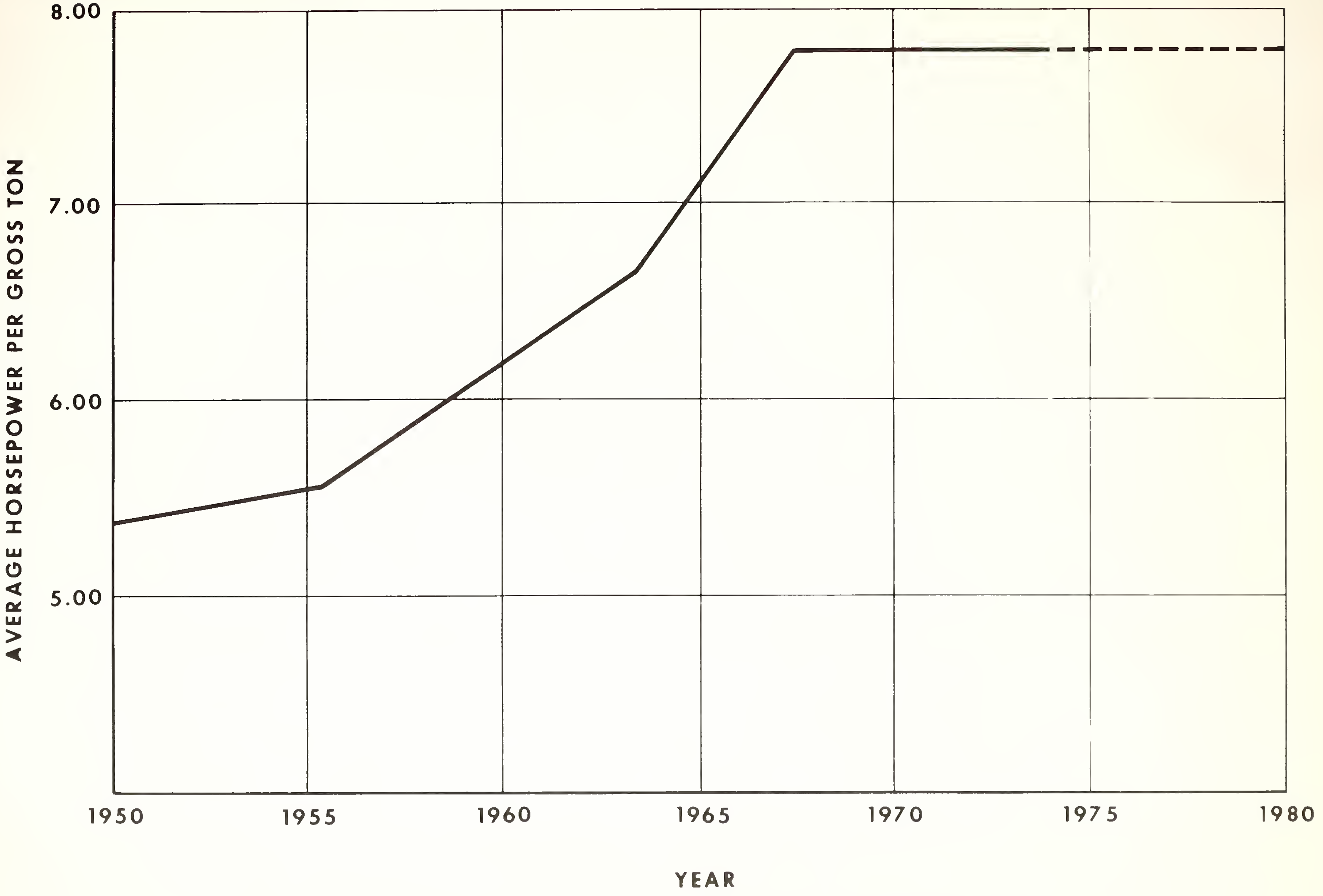


FIGURE 11 TOWBOATS DELIVERED
AVERAGE HORSEPOWER INSTALLED PER GROSS TON

CHAPTER 8

CARGO HANDLING SYSTEMS

This chapter reviews the characteristics and types of cargo handling equipment currently in use on the inland waterways. As noted in Chapter 5, over 20 handling equipment types were identified in the facility inventory for use at solid bulk, liquid bulk, grain and general cargo facilities.

Both diversity and specialization typify inland port cargo handling systems. Diversity of equipment types reflects the variety of cargoes handled. Materials handling equipment tends to be specialized because the facility is generally owned and operated by the end-user of the waterborne commodity. Specialization is dictated by the unique bulk handling requirements of each user; it is made possible by the ready availability of either "off-the-shelf" or customized equipment. Both in terms of volume and value, the bulk material movements on inland waterways significantly exceed those for break-bulk freight and for purposes of this discussion, emphasis is placed upon bulk materials handling techniques.

Constraints imposed by channel widths and depths prevent most inland ports from realizing the cost savings in cargo handling made possible by economies of scale introduced by the superships prevalent in ocean trade. However, as discussed in Chapter 12, improved technology of materials handling equipment with speeded operating cycles and increased capacities generate transport cost savings, through reduction in turn-around times for barges as well as for their ocean-going counterparts. In addition to the traditional bulk cargoes of oil, ores, coal, and grain cereals, an increasingly greater proportion of other commodities - for example orange juice, wine and molasses-- is being handled as bulk in larger quantities or entire ship or barge loads with important transport cost savings.

Primary objectives of this study are to estimate port cargo handling capacity and to evaluate the ability of the ports to accommodate future cargo growth. In this regard, capacity is strongly influenced by equipment handling rates (measured in tons per hour) and for this reason, the chapter emphasizes this particular operating characteristic. It is possible, for example, to increase the capacity of a bulk facility by several orders-of-magnitude by upgrading from a simple bucket loader/unloader to a continuous handling system; comparable improvements in the upgrading of general cargo break-bulk handling rates--with the exception of container systems--are not possible.

SOLID BULK SYSTEMS

Coal and coke, ores, sand and gravel, and dry fertilizers are the most common commodities handled in solid bulk form. The 17-state study area has approximately 1,000 inventoried pieces of equipment used for loading and unloading solid bulk commodities. Much of this equipment is capable of both loading and unloading.

As shown in Table 8-1, the crane-clam shell bucket, in use at about 30 percent of the unloading facilities, is the predominant type of equipment; the bucket has a handling capacity averaging about 200 tons per hour, which is on the lower end of the capacity scale. The front-end loader, a relatively inexpensive highly mobile piece of equipment, with an even lower handling rate, accounts for slightly over 10 percent of the equipment currently in use. On the upper end of the capacity scale are the continuous buckets--with rates as high as 4,000 tons per hour; the gantry crane unloader with single bucket has handling rates which are about half as large. In total, the larger, higher capacity unloading facilities account for about 15 percent of all unloading solid bulk facilities.

TABLE 8-1

SUPERREGION ALL

EQUIPMENT HANDLING RATES FREQUENCY DISTRIBUTION
DRY BULK DISCHARGING (Tons/Hour)

EQUIPMENT TYPE	UPPER LIMIT RANGE VALUE																				TOTAL
	100		200		400		600		800		1000		2000		3000		4000		6000		
	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	
General Cargo/Cont. Crane	2	50	0	0	2	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Straddle Carrier	1	14	6	86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Yard Crane - Other	2	7	6	22	14	52	4	15	1	4	0	0	0	0	0	0	0	0	0	0	27
Shiploader-slewing chute, etc.	0	0	13	62	3	14	2	10	0	0	0	0	2	10	0	0	0	0	1	5	21
Gantry Crane w/Bucket	3	9	5	16	10	31	3	9	3	9	3	9	5	16	0	0	0	0	0	0	32
Pneumatic Loader	0	0	0	0	1	50	0	0	0	0	1	50	0	0	0	0	0	0	0	0	2
Pneumatic Unloader	5	29	7	41	5	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
Marine Leg (cont.bucket)	0	0	0	0	1	6	0	0	1	6	2	11	8	44	4	22	2	11	0	0	18
Gravity Chute Loading Spout	0	0	2	29	0	0	1	14	0	0	0	0	4	57	0	0	0	0	0	0	7
Other	7	54	1	8	2	15	0	0	0	0	0	0	1	8	0	0	2	15	0	0	13
Locomotive Crane	3	60	2	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Front End Loader	19	42	15	33	5	11	6	13	0	0	0	0	0	0	0	0	0	0	0	0	45
Crane w/Magnet	2	40	3	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Crane-Clam Shell Bucket	24	21	41	35	24	21	9	8	11	9	2	2	3	3	0	0	1	1	1	1	116
Bridge Crane	0	0	0	0	0	0	0	0	0	0	2	100	0	0	0	0	0	0	0	0	2
Bulldozer	0	0	0	0	0	0	0	0	1	100	0	0	0	0	0	0	0	0	0	0	1
Conveyor Belt System	2	4	3	7	24	52	5	11	3	7	3	7	3	7	2	4	1	2	0	0	46
Fork Lifts	3	50	3	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Reclaimer	3	19	0	0	8	50	0	0	0	0	4	25	0	0	1	6	0	0	0	0	16
TOTAL	76		107		99		30		20		17		26		7		6		2		390

Source: Mid-America Facility Inventory (initial printout)

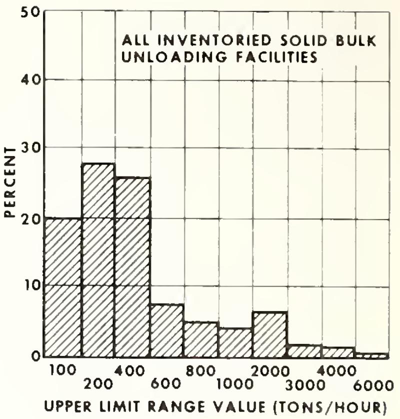


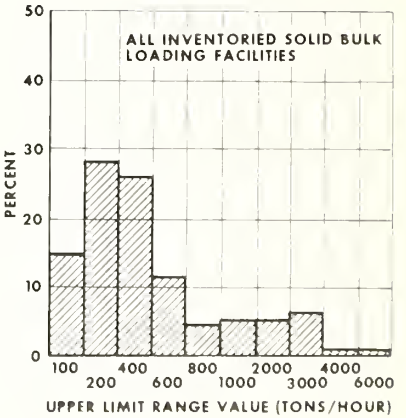
TABLE 8-2

SUPERREGION ALL

EQUIPMENT HANDLING RATES FREQUENCY DISTRIBUTION
SOLID BULK LOADING (Tons/Hour)

EQUIPMENT TYPE	UPPER LIMIT RANGE VALUE																				TOTAL
	100		200		400		600		800		1000		2000		3000		4000		6000		
	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	
General Cargo/Cont. Crane	2	50	2	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Straddle Carrier	0	0	6	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Yard Crane - Other	2	10	6	30	8	40	4	20	0	0	0	0	0	0	0	0	0	0	0	0	20
Shiploader-slewing chute, etc.	1	3	3	10	8	26	13	42	1	3	1	3	1	3	1	3	1	3	1	3	31
Gantry Crane w/Bucket	0	0	4	21	2	11	3	16	1	5	2	11	5	26	2	11	0	0	0	0	19
Pneumatic Loader	2	67	0	0	1	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Pneumatic Unloader	2	33	3	50	1	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Marine Leg (cont.bucket)	1	8	0	0	1	8	0	0	4	33	0	0	2	17	3	25	1	8	0	0	12
Gravity Chute Loading Spout	0	0	4	25	4	25	1	6	1	6	1	6	5	31	0	0	0	0	0	0	16
Other	1	6	3	17	4	22	4	22	0	0	6	33	0	0	0	0	0	0	0	0	18
Locomotive Crane	6	75	2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Front End Loader	17	30	29	51	5	9	6	11	0	0	0	0	0	0	0	0	0	0	0	0	57
Timber Carrier	2	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Crane w/Magnet	2	40	3	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Crane-Clam Shell Bucket	12	18	27	40	17	25	5	7	5	7	0	0	2	3	0	0	0	0	0	0	68
Bulldozer	0	0	0	0	0	0	0	0	0	0	0	0	1	100	0	0	0	0	0	0	1
Conveyor Belt System	2	3	9	12	32	42	7	9	4	5	5	6	1	1	17	22	0	0	0	0	77
Fork Lifts	5	63	3	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Reclaimer	0	0	0	0	10	77	0	0	0	0	3	23	0	0	0	0	0	0	0	0	13
TOTAL	57		114		93		43		16		18		17		23		2		1		374

Source: Mid-America Facility Inventory (initial printout)



Dry bulk loading systems are summarized in Table 8-2. The conveyor belt system and the clam shell bucket, each accounting for about 20 percent of the total loading facilities, predominate. The conveyor belt system has a wide range of handling capacities: on the lower end of the scale, it has an average capacity of 400 tons per hour, while on the upper end, it has a capacity which falls into the range of 2,000 to 3,000 tons per hour. The front-end loader is also used extensively for loading barges.

Coal and Coal Products

Coal and coal products are handled in many sizes and types but in general they can be characterized as being relatively free flowing and of moderately low density in the order of 45 pcf. Consequently, coal can be transferred by belt conveyors, clamshell buckets, chutes, continuous bucket elevators, tunnel and bucket wheel reclaimers, and belt stackers.

Loading systems generally use bucket wheel or tunnel reclaim from storage, belt conveyor transport to dockside and either stationary, traveling or quadrant conveyor boom shiploaders. A number of terminals on the Great Lakes, which are outside the study area, for example, have used elevating car dumpers with loading by chute.

Unloading from barges is by clamshell bucket and, increasingly by continuous bucket elevators. Large vessels use clamshell buckets, and are also beginning to have bucket elevator machines available. Belt conveyors transfer the coal to storage where it is stockpiled by tripper, stacker and, in most instances, distributed by earth moving equipment.

Iron Ores

Iron ore is generally characterized as having moderate to sluggish flowability, with a density in the order of 135 pcf. Iron ore pellets, however, would be free flowing.

Storage is generally in open stockpiles.

Loading systems generally include bucket wheel or tunnel reclaimers, belt conveyor transport to wharves, and loading by stationary, traveling or quadrant shiploaders with belt conveyor booms.

Unloading of most vessels, regardless of size, is accomplished by clamshell buckets, using single or multiple traveling unloaders where required. From the unloader, ore is transferred to open storage by belt conveyors and stockpiled by traveling stackers. Traveling unloading, stacking (and reclaiming) bridges can be used where storage is adjacent to wharf.

Hulett bucket unloaders and self-unloaders which are used on the Great Lakes are not utilized on the inland waterways.

Aggregates, Non-mettalic Minerals and Fertilizers

This category covers a broad range of materials and particle sizes but it is generally characterized by moderate-to-sluggish ability to flow, and moderate density, in the order of 80 pcf.

Aggregates are loaded by conveyor boom mounted on fixed or traveling structures or by stationary chutes. At large facilities, reclaim from storage is by bucket wheel or tunnel conveyor, with the material transferred by belt conveyor to the dock. Loaders are generally belt conveyor boom types, mounted on either stationary, traveling or quadrant machines.

Unloaders are generally of the clamshell bucket type operating from fixed towers, traveling bridges, gantries, or at smaller facilities, from crawler cranes. Materials are either unloaded for direct transshipment, or transferred by belt conveyor to storage and stockpiled by boom stacker or overhead tripper.

Fertilizers and precious non-metallic minerals may be stored in closed storage.

GRAINS

Grains, including barley, rye, corn, oats, rice, soybeans, wheat and others, are characterized by being free-flowing and of low density, in the order of 45 pcf; they generally require covered storage. A variety of mechanical and pneumatic conveying devices are available for moving grains, including belt, screw, chain and drag conveyors; marine leg vertical elevators; bucket elevators; gravity chutes and spouts, and various forms of pneumatic conveyances. Many of these devices are used in the overall loading and unloading systems, and the distribution at storage.

Grain unloading from barges can be accomplished by pneumatic vacuum pipes, marine legs, bucket elevators or grab buckets. These devices can be mounted on traveling towers or gantries and can be used single or in multiples. Belt conveyors are generally used for transfer along wharves and to storage. As shown in Table 8-3, over 50 percent of the existing grain unloading facilities in the study area use some form of continuous handling system - continuous bucket or conveyor belt. On the lower end of the capacity scale, unloading rates average around 300 tons per hour, while the large equipment is typified by rates of 1,200 tons per hour.

In loading, belt conveyors are used to move grain from storage to conveyor galleries on the wharf, from where the materials are usually loaded into the vessels by spouts, some with mechanical trimmers. The loading spouts may be stationary or on traveling towers. When storage silos are adjacent to wharves, the grains may be gravity loaded directly into the vessel by spouts without the need for wharf gallery conveyors.

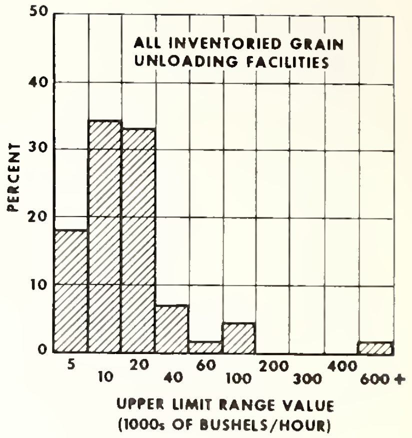
SUPERREGION ALL

TABLE 8-3

EQUIPMENT HANDLING RATES FREQUENCY DISTRIBUTION
BULK GRAIN DISCHARGING (1,000's Bushels/Hour)

EQUIPMENT TYPE	UPPER LIMIT RANGE VALUE 5		10		20		40		60		100		200		300		400		600		TOTAL
	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	
Shiploader-slewing chute, etc.	3	30	0	0	7	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Pneumatic Unloader	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Marine Leg (cont.bucket)	6	30	7	35	4	20	0	0	0	0	3	15	0	0	0	0	0	0	0	0	20
Gravity Chute Loading Spout	2	6	8	24	21	62	1	3	1	3	0	0	0	0	0	0	0	0	1	3	34
Other	0	0	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Front End Loader	1	50	1	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Crane-Clam Shell Bucket	1	25	2	50	0	0	0	0	1	25	0	0	0	0	0	0	0	0	0	0	4
Conveyor Belt System	8	13	27	45	12	20	9	15	0	0	3	5	0	0	0	0	0	0	1	2	60
Reclaimer	2	67	0	0	1	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
TOTAL	24		46		45		10		2		6		0		0		0		2		135

Source: Mid-America Facility Inventory (initial printout)



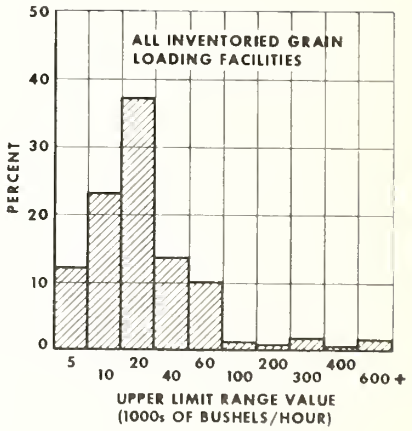
SUPERREGION ALL

TABLE 8-4

EQUIPMENT HANDLING RATES FREQUENCY DISTRIBUTION
BULK GRAIN LOADING (1,000's Bushels/Hour)

EQUIPMENT TYPE	UPPER LIMIT RANGE VALUE 5		10		20		40		60		100		200		300		400		600		TOTAL
	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	NO.	(%)	
Shiploader-slewing chute, etc.	4	9	4	9	20	43	5	11	10	21	3	6	1	2	0	0	0	0	0	0	47
Pneumatic Loader	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Marine Leg (cont.bucket)	2	13	3	20	9	60	1	7	0	0	0	0	0	0	0	0	0	0	0	0	15
Gravity Chute Loading Spout	3	5	7	11	20	32	18	29	14	22	0	0	0	0	0	0	0	0	1	2	63
Other	0	0	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Front End Loader	1	50	1	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Crane-Clam Shell Bucket	1	33	2	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Conveyor Belt System	14	14	36	36	36	36	8	8	0	0	0	0	0	0	4	4	1	1	2	2	101
Reclaimer	2	40	0	0	3	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
TOTAL	28		54		88		32		24		3		1		4		1		3		238

Source: Mid-America Facility Inventory (initial printout)



Over 50 percent of the grain loading is accomplished by direct conveyor belt system, while 25 percent is accomplished by gravity chute loading spout. The smaller facilities are typified by loading rates of around 400 tons per hour, while the larger facilities are typified by rates of about 2,000 tons per hour (see Table 8-4).

LIQUID BULK SYSTEMS

Crude petroleum, petroleum products and selected chemical products are transported in liquid bulk form. The study area has slightly over 200 inventoried pieces of equipment utilized for loading liquid bulks and almost 300 inventoried pieces of equipment utilized in unloading; though not tabulated separately as part of the inventory analysis, it would be reasonable to assume that most of this equipment can perform both loading and unloading functions.

It is not known to what extent the figures contained in the inventory represent only on-shore transfer systems including pumps; the use of barge pumps is prevalent and may be included in the figures cited in this section of the Study.

Tables 8-5 and 8-6 summarize the distribution of liquid bulk unloading rates and loading rates, respectively. About 40 percent of the unloading rates do not exceed 1500 barrels per hour, while another 35 percent fall within the range of 1600 to 3500 barrels per hour. In contrast, about 50 percent of the unloading rates do not exceed 1500 barrels per hour, while 25 percent fall into the 1600 to 3500 barrels per hour range. Conventional cargo hoses are used in the overwhelming majority of cases.

By way of further comparison, it is interesting to note that barge pumping rates are on the order of 900 barrels per hour for the first generation tank barges and approach 1800 barrels per hour for the larger second generation barges.

TABLE 8-5

SUPERREGION ALL

EQUIPMENT HANDLING RATES FREQUENCY DISTRIBUTION
LIQUID BULK DISCHARGING (100's of Barrels/Hour)

EQUIPMENT TYPE	15 NO.	15 (%)	35 NO.	35 (%)	50 NO.	50 (%)	100 NO.	100 (%)	200 NO.	200 (%)	400 NO.	400 (%)	800 NO.	800 (%)	1000 NO.	1000 (%)	2000 NO.	2000 (%)	4000 NO.	4000 (%)	TOTAL
General Cargo/Cont. Crane	0	0	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Both	12	35	7	21	3	9	4	12	3	9	2	6	3	9	0	0	0	0	0	0	34
Conventional Cargo Hoses	[illegible]7	4[illegible]	7[illegible]	35	13	6	4	2	4	2	3	1	6	3	2	1	10	5	3	1	202
Other Mechanical Connectors	6	25	13	54	1	4	1	4	0	0	0	0	1	4	0	0	0	0	2	8	24
Reclaimer	3	38	2	25	0	0	0	0	1	13	1	13	0	0	0	0	0	0	1	13	8
TOTAL	1[illegible]8		9[illegible]		17		9		8		6		10		2		10		6		269

Source: Mid-America Facility Inventory (initial printout)

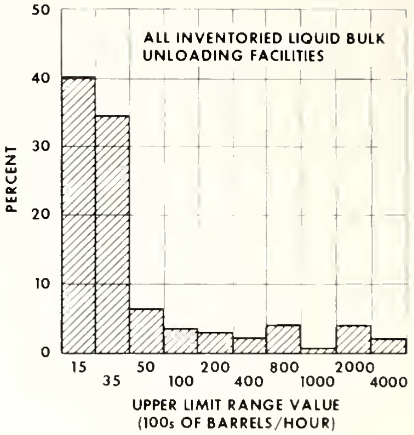


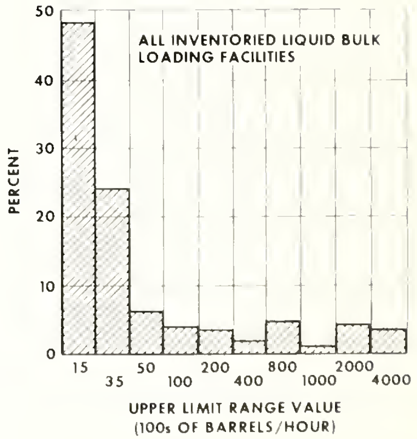
TABLE 8-6

SUPERREGION ALL

EQUIPMENT HANDLING RATES FREQUENCY DISTRIBUTION
LIQUID BULK LOADING (100's of Barrels/Hour)

EQUIPMENT TYPE	15 NO.	15 (%)	35 NO.	35 (%)	50 NO.	50 (%)	100 NO.	100 (%)	200 NO.	200 (%)	400 NO.	400 (%)	800 NO.	800 (%)	1000 NO.	1000 (%)	2000 NO.	2000 (%)	4000 NO.	4000 (%)	TOTAL
Both	14	41	7	21	4	12	1	3	3	9	1	3	4	12	0	0	0	0	0	0	34
Conventional Cargo Hoses	79	5[illegible]	39	26	7	5	3	2	2	1	1	1	4	3	2	1	8	5	5	3	150
Piggy-Packer	[illegible]	0	[illegible]	0	0	0	0	0	1	100	0	0	0	0	0	0	0	0	0	0	1
Other Mechanical Connectors	6	[illegible]	4	2[illegible]	2	10	3	15	0	0	2	10	1	5	0	0	1	5	1	5	20
Reclaimer	[illegible]	[illegible]3	[illegible]	[illegible]	0	[illegible]	1	17	1	17	0	0	1	17	0	0	0	0	1	17	6
TOTAL	1[illegible]1		5[illegible]		13		[illegible]		7		4		10		2		9		7		211

Source: Mid-America Facility Inventory (initial printout)



Barge loading rates are in the same order of magnitude as shown herein for the unloading rates of barges. The loading rates are strictly dependent on the pipe sizes, metering stations, pumping capacities, and loading piping system. In the case of barges where volumes of product to be handled are comparatively small, the capacity of their cargo pumps are not fixed or standardized and the pumping rates vary from 600 gallons per minute or (GPM) 860 barrels per hour (BBL/HR) to 1800 GPM (2570 BBL/HR).

Of interest is the fact that tanker pumps discharge pressures are in the order of from 862 Kpa (125 psi) to 1724 Kpa (250 psi). Also, liquid petroleum cargo volumes will vary with specific gravities and temperatures of the product handled. The bulk of the petroleum products considered have specific gravities in the range of 0.65-0.95; specific gravities are somewhat higher for some crudes. This wide range of gravities will affect the volume of cargo stored, as well as barrel per hour throughput and pumping horsepower.

GENERAL CARGO HANDLING

General cargo refers to a wide variety of cargo types with different handling requirements and can be classified as break-bulk, neo-bulk, palletized, project cargo or containerized. All move on the inland waterways.

Break-bulk cargo is characterized by relatively small, loose parcels such as bags, boxes, barrels or bales. In order to expedite cargo handling, these loose parcels are sometimes consolidated into larger units by using pallets. In a similar fashion, neo-bulk cargoes such as lumber can be handled in larger units rather than as individual boards. Containerized cargo is characterized by the use of rigid freight containers designed for compatibility with marine, rail and truck modes of transport.

Ship to shore transfer of break-bulk and neo-bulk is generally performed by cranes. Shoreside cranes vary widely in their lifting capacities, from 3 to 70 tons, while floating cranes can handle lifts of 100 to 500 tons. Lifting radii are commonly in the range of 60 to 130 feet. Typical handling rates per gang/hour are 20 short tons (s.t.) for mixed break-bulk; 25 s.t. for bagged cargo; 35 s.t. for project cargo; 150 s.t. for lumber ; and 50 s.t. for structural steel.

A crane may be fitted with a variety of attachments including slings, clamshells, magnets, tongs, hooks and spreaders, permitting the handling of such diverse cargo as rolled products, crates, bags, scrap metal, barrels, vehicles, dry bulks and containers. Mobile cranes are often preferred for their ability to be moved from berth to berth or to other locations such as storage yards. Modern cranes are of the level-luffing variety which perform luffing motions with relatively little power consumption.

Palletized cargo may be handled with slings or with specially fabricated equipment having jaws that slide under the pallets. Food products and other small manufactured and packaged goods are frequently stacked on pallets.

Project cargo refers to large items such as boilers, condensing units and turbine rotors for power plants, and offshore oil drilling equipment. Saturn rocket boosters for example, are shipped on the inland waterways from Huntsville, Ala. to Cape Kennedy. Handling of such bulky cargoes may entail the use of large cranes, flotation devices, or specially designed equipment.

An increasing share of inland waterways general cargo is being carried in containerized shipments. Despite the fact that containerization offers the advantages of rapid cargo handling, intermodal capability and low risk of damage to freight in transit or storage, growth will be constrained by the fact that barge transit time relative to other modes is excessive: the high value commodites normally shipped by container require minimum transit times to keep inventory costs at reasonable levels. Disadvantages are the high initial investments required to establish a container operation and the need to ship empty containers on trade routes with unbalanced commodity flows. Several container sizes are in use, the most common being 8x8x20 feet and 8x8x40 feet, with some having heights up to nine feet or intermediate lengths.

CHAPTERS 9 TO 15

ANALYSIS AND FORECAST PHASE

CHAPTER 9

INSTITUTIONAL ASPECTS OF PORT DEVELOPMENT

Riverport development is a complex process in which Federal, state and local governments interact with each other and with private enterprises engaged in water transportation. In this complex process, Federal interests alone may be represented by as many as a dozen agencies. Although state government responsibilities for ports and waterways are generally less fragmented than those of the Federal government, they have sometimes been poorly defined. In some states, responsibility for riverport development is lodged in agencies not historically identified with water transportation.

National interest in the navigable waters of Mid-America is older than our Federal government. In 1787 the Continental Congress declared the navigable waters leading into and between the St. Lawrence and Mississippi Rivers to be common highways open to all on equal terms.

The Federal government has always exercised some responsibility for improving harbors and waterways, with Federal investments in harbors beginning in 1789. The Federal waterway improvement program was initiated in Mid-America on May 24, 1824, with an appropriation of $75,000 for improving navigation over sand bars in the Ohio River and for removing snags from the Ohio and Mississippi Rivers. That legislation set the basic pattern for waterway and port development in the United States. Channel and harbor improvements in navigable waters became essentially a Federal government responsibility; but construction and administration of port facilities has remained a local function throughout our history.

Federal interest in inland waterways has always been both developmental and regulatory. The regulatory responsibilities have been delegated to various Federal agencies, but the

Congress has always retained a large measure of responsibility for improving harbors and channels. That function is performed in accordance with individual legislative authorizations through which the Congress makes funds available for specific projects after considering economic analyses that deal with each project as a separate entity clearly oriented to local considerations and objectives.

NATIONAL POLICIES

Fundamental Federal port policy, enunciated in Article I of the Constitution, states that the government's regulatory processes shall give no preference to the ports of one state over those of another. Equality of treatment for all ports is the basic standard to which Federal water transportation policy is expected to adhere.

Constitutional provisions with respect to ports, as with other matters derived from the experience of the Atlantic Seaboard colonies whose foreign and domestic commerce was based primarily on water transportation. Land transportation of goods was difficult and costly. Domestic shipments moved almost entirely through coastwise channels and inland waterways. Colonial ports served as coastal gateways for clearly separated hinterlands. Ports did not come into serious competition with each other until the hinterlands were vastly extended and penetrated with railroads and highways.

Development of rail and highway systems brought competitive intermodal interests into the public arena. The preamble to the Interstate Commerce Act of 1940 addresses this issue. It summarizes national policy with respect to regulation of transportation as follows:

> "It is hereby declared to be the national transportation policy of the Congress to provide for fair and impartial regulation of all modes of transportation subject to the provisions of this act, so administered as to recognize and preserve the inherent advantages of each; to promote safe,

> economical and efficient service and foster sound economic conditions in transportation and among the several carriers; to encourage the establishment and maintenance of reasonable charges for transportation services, without unjust discriminations, undue preferences or advantages, or unfair or destructive competition practices; to cooperate with the several States..; and to encourage fair wages and equitable working conditions -- all to the end of developing, coordinating and preserving a national transportation system by water, highway and rail, as well as other means, adequate to meet the needs of the commerce of the United States, of the Postal Service, and of the national defense."

Traditionally, most docks and terminals on inland waterways have been developed with private capital. Most of the terminals along the rivers continue under private ownership and control. Many serve a single purpose and are not used by the public. In addition, publicly owned terminal facilities are typically operated by private firms under long-term leases.

Despite a widely held consensus that ports are in the national interest, Federal policy with respect to port development is fragmentary at best. There is no national port development program to which riverport development in Mid-America can be related.

Nevertheless, there is a long-standing Federal policy that recognizes governmental responsibility for providing terminal facilities on the navigable waterways of the United States. The River and Harbors Act of 1919 states that:

> "...water terminals are essential to all cities and towns located on harbors or navigable waterways and...at least one public terminal should exist, constructed, owned, and regulated by the municipality, or other public agency of the State and open to the use of all on equal terms." (Act of March 2, 1919; 40 Stat. 1286; 33 U.S.C.A. 551)

In recent years national policy on ports and waterways has been characterized by increasing environmental concern. The statutory basis for a comprehensive pollution program was firmly established by the Federal Water Pollution Control Act Amendments of 1972, which set as a national goal complete elimination of pollutant discharges into navigable waters by 1985. In pursuit of this objective, the Environmental Protection Agency administers a nationwide Federal-state water permit program known as the National Pollutant Discharge Elimination System. This program prescribes point source effluent standards and limitations that pollutant dischargers will be required to meet.

The historical Federal policy of financing inland waterway improvements entirely from general revenues of the United States government was significantly modified in 1978. Legislation enacted in the closing hours of the 95th Congress imposes a waterway user charge. This action was taken in conjunction with authorization for replacing Locks and Dam 26 on the Upper Mississippi River. The new law taxes fuel used by the commercial barge industry on the inland waterways. Revenues derived from this tax will be put into a trust fund to be used in financing construction and rehabilitation projects. The tax levy begins at four cents a gallon in 1980 and is scheduled to increase to ten cents a gallon in 1985. The trust fund is expected to total $30 million by 1981 and $101 million by 1985. Under the new law, the cost of operating and maintaining the waterways will continue to be financed from general revenues. It requires the Secretaries of Transportation and Commerce to give further study to the effect of waterway user charges and to submit a report to the Congress by 1981.

FEDERAL AGENCIES

The U.S. Army Corps of Engineers is the Federal government's agent for planning, improving and maintaining navigable waterways. The Corps' planning activities include engineering feasibility studies, cost analyses, economic assessments, environmental assessments, environmental impact statements and preparation of detailed budget justifications for consideration by the Congress, which authorizes and appropriates funds for specific river and harbor improvements. Pursuant to such statutory authorization, the Corps performs engineering and construction work -- dredging channels to authorized depth and width, maintaining harbors, removing obstructions to navigation, and building, operating and maintaining locks and dams.

Other functions of the Corps of Engineers include establishing harbor lines beyond which piers, wharves and bulkheads may not extend, removing structures erected illegally in streams and defining anchoring areas for vessels. The Corps also issues permits for construction of other work in or over navigable waters.

The Federal mandate for promoting waterborne commerce rests on the Maritime Administration of the U.S. Department of Commerce. Section 8 of the Merchant Marine Act of 1920 directs the agency to promote, encourage and develop ports and transportation facilities for water commerce. Statutorially prescribed functions include investigating port economies, the flow of commerce, congestion at ports and the rates, charges, rules or regulations of common carriers. The Act requires the agency to study water terminals, including docks, warehouses and related equipment; to provide advice to communities relevant to local planning for wharves, piers and water terminals; and to investigate the practicability of harbor, river and port improvements.

The Maritime Administration has exercised the port development mandate with increasing effectiveness in recent years. This has been reflected primarily in promotion of integrated transportation systems and program activities aimed at meeting the broad responsibilities set out in the 1920 law; e.g. the summary report on Planning Criteria for U.S. Port Development issued by the Office of Port and Intermodal Development in December 1977.

Taking cognizance of related environmental considerations, the Maritime Administration has offered technical assistance for development of pollution abatement equipment and assessed the impact of Federal water pollution control legislation on the domestic waterborne commerce of the United States. Its analytical studies have documented the economic and safety advantages of transporting hazardous materials by barge when a choice of surface modes is available.

Federal policy has clearly come to embrace cooperative planning with state governments through organizations such as the river basin commissions established in accordance with Title II of the Water Resources Planning Act. Such a commission may be set up whenever the Water Resources Council determines that the states in a major river basin want to undertake coordinated water resources planning. In Mid-America, commissions have been established in the Ohio, Upper Mississippi and Missouri basins. The commissions include representatives of Federal water resources planning agencies and their counterparts in state government. They are concerned essentially with water and natural resource planning and setting priorities for physical development projects. The Upper Mississippi River Basin Commission illustrates how these collaborative efforts are structured.

The Upper Mississippi River Basin Commission was created by executive order of the President in 1972. It is composed of representatives of six states and ten Federal agencies. Its headquarters office is located at Fort Snelling, Minnesota. The Commission has organized the Great River

Environmental Action Team (GREAT), which is engaged in a comprehensive multi-purpose resource management study for the upper Mississippi River. The objective of this project is to develop a plan for the river incorporating in a balanced way total water resource requirements -- including commercial navigation, fish and wildlife and recreational use of the river. Problems associated with channel maintenance and placement of dredge materials are key issues. Participating Federal agencies are the Corps of Engineers, Fish and Wildlife Service, Environmental Protection Agency, Bureau of Outdoor Recreation, Soil Conservation Service and U.S. Coast Guard. State participation includes the Illinois, Iowa and Missouri conservation departments; the Illinois Division of Water Resources; the Minnesota and Wisconsin departments of natural resources; and the Minnesota Pollution Control Agency.

STATE GOVERNMENT ROLE IN PORT DEVELOPMENT

Historically, port development in the United States has been accomplished by local agencies. Prior to the twentieth century, terminal facilities at ocean harbors and on inland waterways were generally under private ownership and operation. Ownership was typically vested in railroad companies, terminal companies specifically created for that purpose, or industrial firms that relied heavily on water transportation.

At the turn of the century there were only four public port authorities in the United States. Since 1900 there has been a vast expansion in public ownership of port facilities, but ownership and operation of port facilities has continued to be predominantly local, especially on the inland waterways. State ownership and operation of port facilities, an option exercised in Alabama, has seldom been employed elsewhere, although ocean ports in Hawaii and Connecticut are administered by their respective state departments of transportation. Except in Alabama, outright state ownership and operation is not characteristic of port facilities on inland waterways. Outside Mid-America some special-purpose statewide agencies or port authorities have been created for the purpose of developing and managing ports. Along the Eastern Seaboard such state agencies exist in Massachusetts, Virginia and South Carolina. Maryland operates a statewide variant as part of its Department of Transportation.

Among riverport officials there is a clear consensus that the most significant contribution a state government can make to port development in the inland waterway system is to provide firm legislative authority for exercise of local initiatives. Nine Mid-America states have general enabling statutes that authorize local governments to create port authorities. Mid-America states with such legislation are Arkansas, Kansas, Kentucky, Minnesota, Missouri, Nebraska, Ohio, Oklahoma and Pennsylvania. Three states -- Illinois, Louisiana and Tennessee -- have accomplished the same objective through a series of individual, though very similar statutes that authorize creation of special-purpose bodies through which port facilities are developed and administered.

In Alabama, Mississippi and Wisconsin riverport development is a responsibility assigned to agencies closely integrated with the structure of general government. Alabama relies on state ownership for development and operation of port facilities. In Mississippi and Wisconsin riverports are developed and administered by local port commissions, created pursuant to general enabling statutes. These commissions are an integral part of the local general governments with which they are associated.

Some public riverport authorities have been set up primarily for planning and regulating development of port facilities, while others have a mandate to develop and operate facilities. When public agencies develop terminal facilities, they usually lease them to private operators. However, many port authorities operate and maintain some or all of the docks, terminals and other facilities they own.

A riverport authority, like its seaport counterpart, is typically a semi-autonomous public body that exercises some power to sue and be sued. Riverport authorities characteristically have much independence in raising funds and administering revenue-producing facilities.

The Prevailing Pattern and Variations

The enabling acts by which twelve Mid-America states have established local port authorities are much alike. They are also similar to statutes of other states that have created public authorities at ports on both oceans and on the Great Lakes. They specify the manner in which local governments may act to set up an authority and they empower the authorities so created to perform the following functions:

- To acquire, construct and equip docks, warehouses, terminals and related facilities;
- To construct, acquire, maintain and operate basins and canals;
- To exercise the right of eminent domain for acquisition of land, rights-of-way and easements;
- To enter into contracts, leases and other agreements with companies engaged in transportation, storage or shipment of goods and commodities;
- To receive grants, gifts, donations or other monies from the Federal government, the state or its political subdivisions, or other public agencies;
- To incur debt and issue bonds or notes, pledging revenues derived from their properties and facilities or received from other sources;
- To promote, advertise and publicize their port facilities; and
- To appear before regulatory agencies on behalf of the port and its users.

Some enabling acts specifically authorize local port authorities to operate, maintain and administer public docks, wharves, sheds and other terminal or transportation facilities. In other states, enabling legislation forbids port authorities to engage in terminal operations. In most states, local port authorities may acquire, own, develop, maintain and lease land or facilities for industrial use. In its enabling statutes each state generally uses terminology and prescribes functional responsibilities somewhat differently in accordance with its own traditions and the geographic and historic circumstances that shaped its response to the requirements of water transportation. For example, Illinois statutes refer to the local port development entities as port districts, although they have the general character of bodies politic and corporate that are elsewhere referred to as "authorities". During the past thirty years the Illinois legislature has created thirteen port districts with individually approved enabling acts. However, the language of these statutes is almost identical except in matters of geographic identification.

Louisiana has placed the power to develop, maintain and operate deepwater ports in boards of commissioners, which also have the general character of authorities. However, other special purpose bodies for developing riverport facilities in Louisiana are usually called "authorities." The legislature has created these local port authorities in many places, each with its own enabling statute. Major seaport authorities, operating under statutes of long standing, are authorized to finance, acquire, construct, operate and maintain port facilities. General obligation bonds and revenue bonds provide the framework for each port's capital improvement program. A similar pattern appears to be developing on a smaller scale for the newer riverport authorities, most of which have only limited operating capability at this time.

Beginning in 1955 a series of individual statutes authorized riverport authorities for various Tennessee counties and towns. However, the principal port in Tennessee is administered by the much older Memphis and Shelby County Port Commission, operating under the Charters of the City of Memphis and Shelby County (Tennessee Private Acts of 1947). Its predecessor organization began operations thirty years earlier when the City of Memphis was authorized to construct, own and operate river terminals and warehouses, to exercise the powers of eminent domain for site acquisition, and to issue bonds for facility development.

Unlike port authorities which operate as public corporations, the port commissions of Mississippi and Wisconsin do not have the right to sue or be sued or to issue securities under their own corporate names. However, most port commissions resemble authorities in that they acquire land and facilities, often by condemnation. They are typically directed to prepare plans, to develop the port and to construct approved facilities. Many commissions are authorized to undertake related activities. They are generally the local government's agent for regulating privately owned terminal facilities in the port. Some port commissions operate public terminals, especially in communities where such facilities are deemed necessary but would not exist without tax exemption or other public subsidy.

The legislatures of Iowa and West Virginia have never enacted either a general or a site-specific statute authorizing creation of local public port authorities. In Iowa, planning responsibility for water transportation has been assigned to the new Department of Transportation. Motivated by a requirement for moving grain as efficiently as possible on a year-round basis from Iowa to deepwater ports on the Gulf Coast, the department has initiated feasibility studies for development of appropriate rail/barge interchange facilities. West Virginia has thus far made no institutional provision for riverport and waterway development. Bills aimed at setting up a port authority in the Huntington area have been rejected by the legislature in several successive years.

State Policies on Port Development

Examination of the organizational, functional and financial arrangements for port and harbor development in the Mid-America states discloses wide variations in state policies. Policy variations such as those reflected in the institutional arrangements described in the preceding paragraphs become even more evident in connection with the planning and financing of water-related transportation facilities.

In coastal states waterway and riverport development policies are strongly influenced by long-standing experience with deepwater ports. State involvement in and financial support for development of water transportation facilities is generally accepted public policy in these states. For example, the Greater Baton Rouge Port Commission pursuant to its enabling statute may issue up to $15 million in bonds secured by the revenues derived from operation of the Commission's facilities, and backed by the full faith and credit of the parishes within which lies the area over which the Commission has jurisdiction and of the State of Louisiana.

In an inland state, e.g. Nebraska, the financing of riverport facilities is dealt with much more gingerly. While any Nebraska municipality may establish a dock board and issue revenue bonds payable from user fees, operating charges, or other revenues earned by the dock board's facilities, state law specifically provides that the city "shall incur no indebtedness of any kind or nature upon issuance of such bonds" and may not pledge its credit or taxing power for payment of principal or interest.

In some states there is virtually no policy to which riverport development can be related. However, as the economic benefits of an inland waterway capability become clearer, the policies of inland states with respect to development of riverport facilities are likely to become more explicit. Some of these states have recently given statutory expression to policies on waterway and port development. In Arkansas, for example, the legislature has determined that ports, harbors, barge terminals and related facilities are "necessary for and useful in securing and developing industry in the State of Arkansas."

Two recent trends in state government policy and organization are likely to have a significant long-range impact on riverport and waterway development in Mid-America. Both reflect an emerging public commitment to planning. State departments of transportation have been set up in response to public demand for more coordination in planning and development of transportation systems. Increasing urbanization, growth of metropolitan complexes and competition for limited resources have given impetus to development of comprehensive planning capabilities in state governments.

This national trend is clearly evident in the approach Mid-America states are taking to transportation planning. Of the seventeen states participating in this study, thirteen now have departments of transportation. A decade ago only one of these states had such a department.

Mid-America states that have established departments of transportation and year of establishment are as follows: Arkansas (1977), Illinois (1972), Iowa (1975), Kansas (1975), Kentucky (1973), Louisiana (1976), Minnesota (1976), Missouri (1974), Ohio (1972), Oklahoma (1976), Pennsylvania (1970), Tennessee (1972) and Wisconsin (1967).

The relationship of the state department of transportation to the state and local agencies responsible for port and waterway development varies from one state to another. However, the legislative mandate of the state department of transportation always prescribes a coordinative multi-modal planning role for the department.

Because state departments of transportation have come into existence so recently, the art of multi-modal transportation planning as practiced by these agencies is still fairly primitive. The typical state department of transportation in Mid-America now has well-developed plans and programs for dealing with the highway mode and only relatively fragmentary programs for water transportation and other surface modes.

In some states, strong legislative or executive leadership has promoted creation of institutional structures for comprehensive planning with which development of transportation plans must be articulated. Two basic objectives, both of which may have a significant impact on riverport planning, are identifiable in state government planning programs. They may be described as (1) development-oriented and (2) issue-oriented. In the first group, state-sponsored planning is aimed at growth or economic development as the driving principle. The efforts of the second group are generally focused on key policy issues arising out of social problems, environmental concerns, and alternative uses of physical resources.

The Federal government has fostered many state planning activities through the grant programs administered by the Economic Development Administration, the Department of Housing and Urban Development, the Department of Energy and other agencies. Coastal states are engaged in planning activities under grants made available by the National Oceanographic and Atmospheric Administration pursuant to the Coastal Zone Management Act of 1972. States are also gaining considerable experience in federally sponsored planning activities directed at railroad reorganization and development of regional airports. However, state planning activities have not yet become sophisticated enough so that tradeoffs among different transportation modes or between transportation requirements and other economic needs can be evaluated effectively by policy makers in state governments.

FISCAL ASPECTS OF PORT DEVELOPMENT

Examination of the inland waterways system inevitably brings into focus the large role played by the Federal government. Because the U.S. Corps of Engineers administers and finances construction, maintenance and repair of navigable rivers, harbors, channels and waterways (including flood control and shoreline protection), waterway-related development by state and local government is clearly oriented to Federal leadership, planning and financing. However, public riverport facilities (like their seaport counterparts) have been financed largely with local and state support.

Heavy capital investments in port facilities, like other public facilities developed by state and local governments, generally depend on one or a combination of the following methods of financing: (1) direct appropriations and grants from general revenues of the government; (2) long-term borrowing through general obligation or revenue bonds; and (3) exercise of taxing authority for specific public purposes. All of these methods have been used successfully for developing harbors and riverport facilities in Mid-America. A comprehensive port development program usually involves a combination of these methods. It may include others, such as long term loans secured by mortgages on facilities or short term borrowing from public or private institutions. Operating revenues generated by the enterprise are sometimes the source of capital for small facility improvements, but they are more frequently pledged as security for the debt service requirements of a bond issue.

Harbor and channel improvements made by the Corps of Engineers are financed by Federal appropriations and states have sometimes appropriated funds for such improvements. But port facilities in Mid-America are seldom financed wholly out of direct appropriations from the general revenues of state and local governments, when this is authorized by the enabling statutes.

When state, county and municipal governments undertake development of port facilities, they frequently issue general obligation bonds, which pledge the full faith and credit of the governmental entity that issues them. Their primary security derives from the taxing power of the issuing or guaranteeing government. Although a general obligation bond issue may be secured in the first instance by a pledge of special revenues, its essential character is maintained when any deficit in meeting principal and interest payments is covered by the government's pledge of general revenue support.

The Little Rock, Arkansas experience demonstrates how general bonds are often used to help a public port enterprise get underway. Initial funding of the Little Rock Port Authority was accomplished by means of general obligation bonds issued by the City of Little Rock in 1964. That $4.4 million bond issue required a 1.85 mill property assessment. It was be paid out by 1979. That bond issue financed purchase and development of about 1,140 acres of land, which became the Little Rock Port Industrial Park. Land sales in the industrial park have enabled the authority to acquire additional acreage on the waterfront and to develop necessary harbor facilities.

General obligation bonds are the mode of financing most suitable when state, county and municipal governments undertake development of harbor or waterway facilities that cannot reasonably be supported by user charges. State statutes sometimes contain provisions that make use of general obligation bonds attractive for riverport development. In Mississippi, the board of supervisors of a county that establishes a port commission may issue general obligation bonds for port development in amounts up to $6 million, which is not included in calculating the county's debt limit.

Revenue bonds, which pledge as security the income derived from a specific facility or a clearly identified complex of facilities, are the most widely used method of financing riverport development in Mid-America. They have come into general use by local governments, as well as by port authorities, to finance development of industrial parks. The power to issue revenue bonds for riverport development may be vested in a state agency, a local government or a port authority. In any event the bond issuance power derives from state statutes.

Chapter 68 of the Missouri Revised Code, 1975, sets forth in contemporary legislative language the statutory provisions under which port authority bonds may be issued in that state. It reads in part as follows:

> "Every local and regional port authority, approved as a political subdivision of the state, may...issue its negotiable revenue bonds or notes in such principal amounts as, in its opinion, shall be necessary to provide sufficient funds for achieving its purposes, including the construction of port facilities; establish reserves to secure such bonds and notes; and make other expenditures incident and necessary to carry out its purposes and powers...Any such notes or bonds shall not be a debt of the state and shall contain on the face thereof a statement to such effect."

When the legislature creates a port development agency in the form of a special district, it may give the district taxing powers. More frequently, the statutes vest taxing authority in the general government and authorize the county or municipality to use revenues so obtained for port or waterway development. When the proceeds of a tax levy are pledged along with operating revenues to secure a revenue bond issue, the authorizing statute usually requires electoral approval of the tax levy. For example, an Ohio port authority may levy a tax of one mill annually for five years on the total value of all property within its jurisdiction. The proceeds are available for performance of any authorized port authority function. If the tax is for payment of bond debt charges, the taxing authority once affirmed in an election continues for the life of the indebtedness.

While state government support of port and waterway development usually follows the pattern of general obligation bonds or guarantee of locally issued revenue bonds, some states have evolved interesting variations. In Louisiana, general obligation bonds issued by the Lake Charles Harbor and Terminal District were additionally secured by a pledge of the net operating revenues and by a pledge of money received by the District from the State of Louisiana in the amount of 1/20th of the money received by the State from the proceeds of a motor fuel tax levied and collected by the State under authority of Article VI-A of the Constitution (of 1921). These pledges of operating revenues and fuel tax avails are also common to the revenue bonds issued by the District up until 1974. Under a 1975 Act of the legislature, the gasoline tax levied by Article VI-A of the 1912 Constitution will continue to be credited to the Lake Charles Harbor and Terminal District until its outstanding bonds and other obligation for which these avails are pledged have been paid in full. This provision applies only to obligations outstanding on December 31, 1974. The Louisiana State Constitution of 1974 makes no pledge of gasoline tax avails.

When support of riverport development rests on a firmly held consensus regarding the port's economic importance to the community, the use of various innovative approaches to supporting development is an approach that is readily understood in most riverport communities. Complementary planning for highway and water transportation facilities can give a significant boost to riverport capabilities. Close coordination with economic development activities supported by grants from Federal or state sponsors is sometimes the key to developing financially viable port plans.

As bodies politic and corporate, port authorities are exempt from payment of ad valorem taxes. This tax exemption constitutes a basic advantage that public bodies enjoy in the ownership and management of port facilities. Because development, maintenance and operation of general cargo handling facilities are seldom an economically viable enterprise for private investors, development of such facilities under public management may be the only feasible way of getting such facilities developed. Tax exemption associated with public sponsorship of port facilities is a very significant element of public support for riverport facility development in Mid-America.

Nonmonetary assistance by local governments can also play a significant role in a port facility development program. Such assistance is generally authorized by statute. For example, the City of Tulsa, Oklahoma has made available to the Tulsa-Rogers County Port Authority more than 2,000 acres of city-owned land under a long-term lease, which extends to the year 2075 and requires no payments to the city. The port authority manages development of this land and leases it to tenants under conventional rental agreements. To finance facility development, the authority may permit a tenant to withhold a portion of his rental payment; when completed, title to such facilities passes to the authority.

State governments have sometimes contributed to riverport development. as has the Federal government, through measures aimed at other primary objectives, e.g. urban renewal and job creation. Under the terms of Minnesota's Industrial Development Act, a port authority or any city authorized to exercise the powers of a port authority is included in the definition of a "redevelopment agency." Redevelopment agencies have broad authority to acquire and develop real property, issue revenue bonds, enter into revenue agreements, accept grants and perform similar developmental functions.

Incidental Federal Assistance to Riverport Development

Various Federal agencies have contributed to riverport development through mission oriented programs designed to stimulate community improvement and economic growth. When local planners have succeeded in focussing such resources on waterfront needs, they have sometimes obtained significant support for relevant planning or facility development projects.

The U.S. Department of Housing and Urban Development has helped state and local governments develop comprehensive planning programs. Many state, local and areawide multijurisdictional agencies in the Mid-America area have used HUD grants to improve their planning and managerial capabilities. However, the major thrust of the Department's grant programs is aimed at mitigating physical and economic distress. Urban development grants, for example, are made to "severely distressed cities and urban counties to help alleviate physical and economic deterioration through reclamation of neighborhoods having excessive housing abandonment or deterioration and through community revitalization in areas of population outmigration or a stagnating or declining tax base."

A depression-launched agency with a mandate to conduct a comprehensive program of resource conservation and development, the Tennessee Valley Authority has worked vigorously to promote the Tennessee Valley economy. TVA dams on the Tennessee River and its larger tributaries have since 1937 controlled floods on the Tennessee, Ohio and Mississippi Rivers. The system provides a continuous nine-foot navigation channel from Knoxville, Tennessee, to Paducah, Kentucky, a distance of 650 miles. The Authority operates the river control system and monitors its effectiveness. It works with state and local agencies to promote wider industrial and commercial use of the system's navigable waters.

The Appalachian Regional Commission was created in 1965 for the purpose of stimulating "substantial public investments in public facilities that will start the region on its way toward accelerated social and economic development." A natural ally for state and local governments in the area, the

ARC can make available a considerable range of planning and development help. The Appalachian Region includes all of West Virginia and parts of Alabama, Kentucky, Mississippi, Ohio, Pennsylvania, Tennessee and six other states. The Appalachian Regional Development Act of 1965, as amended, authorizes the Commission to carry out a broad spectrum of economic development programs in the 397 counties under its jurisdiction. Section 214 of that act enables the Commission to pay all or part of the Federal share of any grant-in-aid project authorized under Federal law.

Industrial site development is becoming an increasingly significant part of ARC programs. Its support of the Blair Bend project on the Tennessee River illustrates how this aspect of ARC activity may affect port and waterway development. This project had its origin in a Tennessee Valley Authority study that identified Blair Bend in Loudon County, Tennessee, as one of the best remaining sites for industrial development on the Tennessee River. Investigation indicated that this 280-acre site with its 8,000 feet of waterfront could yield many jobs and open the area for industries requiring water transportation. ARC thereupon made a grant of $667,000 to the City of Loudon to help acquire and develop the site for industrial use, including provision of a rail spur, water and sewerage facilities, site preparation and drainage.

Title V of the Public Works and Economic Development Act of 1965 authorized creation of regional development commissions in the areas other than Appalachia. Under a recent amendment of the Act, all states in the Mid-America study area are now served by one or another of the Title V commissions. Most of the funds distributed by Title V commissions have been used to supplement other Federal contributions to development projects, e.g. industrial parks, sanitary engineering facilities, water systems, access roads, airports and vocational schools. With approval of the Secretary of Commerce, the Title V commissions may also finance planning studies, demonstration projects and training programs without other Federal agency participation.

The Ozarks Regional Commission, which serves five states in the Mid-America study area, has contributed to the support of more riverport development projects than any other Title V commission. During 1977, for example, the ORC and the Economic Development Administration jointly announced grants totaling $1,201,800 to help develop a general cargo port and stimulate economic growth in Madison Parish, Louisiana. These grants are supporting development of a general cargo dock, a storage area, mooring dolphins, an access road and a water line.

The U.S. Department of Commerce, through the Economic Development Administration, provides help for "construction of public facilities needed to initiate and encourage long-term economic growth" in areas where economic growth is lagging behind the rest of the United States. Through EDA programs, grant funds have been made available for more than a decade to state and local organizations that undertook approved studies (usually economic analysis and feasibility studies) or capital improvement projects that constitute the infrastructure for local economic development programs.

Although a recent study of Federal Port Policy in the United States characterized the Economic Development Administration's Program as having low involvement in and low impact on port development in the United States, that agency has often supplied critically needed assistance in putting together an integrated port and community development plan or in filling port-related gaps in a community-wide economic development program. An alert riverport management can make creative use of EDA resources. For example, the Pine Bluff-Jefferson County Port Authority has developed its 373-acre Harbor Industrial District with a financing package consisting of a $1.2 million general obligation bond issue approved by the voters in 1965 and a matching grant of $1,206,000 from the Economic Development Administration. This was supplemented in 1968 with the proceeds of a $645,000 revenue bond issue. After providing roadways and utilities, the Authority had about 300 acres available for occupancy; more than 100 acres of industrial sites have already been sold. Port facilities, including a 20-acre public terminal and a large bulk liquid storage facility, have been developed by the Authority for lease to a terminal operator.

Under an interagency agreement, the Maritime Administration serves as port-consultant to the Economic Development Administration, participating in the review of grant and loan applications for technical assistance or public works projects in port areas.

PRIVATELY FINANCED DEVELOPMENT

Industrial riverfront facilities come into being largely as the result of a great many private investment decisions. They present the Mid-America community with a continuous systematic planning requirement -- to keep abreast of what has been or is being done by private as well as public organizations to meet foreseeable requirements for water transportation in the area.

Privately owned waterfront facilities are the outcome of corporate planning done in many different places, much of it remote from the sites at which construction eventually occurs. The American Waterways Operators, Inc., reports that since 1952 more than 10,600 water-oriented industrial plants have been built or substantially expanded along the navigable inland waterways of the United States. Investment represented by these private developments exceeded $190 billion. In 1977 alone, AWO recorded 199 new plants or expansions in the Mid-America study area. The 155 plants for which AWO recorded investment data in that year represent an estimated capital outlay of $5.3 billion. Distribution of new and expanded sites recorded in 1972 and the associated capital investments are summarized by river system in Table 9-1.

HISTORIC INSTITUTIONAL INFLUENCES

The historic dichotomy in our national policy on waterway and waterfront responsibilities tends to preclude development of an optimum inland waterway transport capability. As the National Academy of Science study, Port Development in the United States (1976) points out, among the major nations only the United States acts on the premise that channel and harbor improvements are a national function while development of port facilities is primarily a local responsibility. Future evolution of the inland water transportation system calls for bridging the gap between national and local functions. This can and should be done in a manner consistent with established patterns of intergovernmental relationships.

During the next few decades developmental emphasis on the inland waterway system will shift from navigation channels and harbors to waterfront facilities. The waterway system is now largely in place. When the large projects already under construction have been completed, configuration of the system will have been fixed for the foreseeable future.

The low-cost waterways have already been developed and the newer ones, e.g. the Tennessee-Tombigbee Waterway, appear to involve very high public investments. Such projects will undoubtedly face increasingly greater challenges growing out of more sophisticated intermodal analyses, more extensive use of present value investment analysis for public projects, and electoral pressure to contain public expenditures for all purposes. This will encourage Federal decision-makers to use available funds to upgrade existing navigation facilities rather than undertake extraordinarily costly extensions of navigation capability. Meanwhile, a more energy-conscious economy will prompt intensified development and redevelopment

TABLE 9-1

NEW PLANTS AND MAJOR EXPANSIONS ON MID-AMERICA WATERWAYS - 1977

River System	Sites Recorded	Estimated Investment (in millions)	Sites Covered By Estimate
Alabama River	7	$ 292.8	7
Black Warrior-Tombigbee	5	22.0	3
Coosa River	1	3.3	1
Cumberland River	2	5.3	2
Green River	2	80.0	1
Illinois Waterway	3	100.0	1
Kanawha River	8	34.1	7
Kentucky River	7	18.35	7
McClellan-Kerr System	13	91.7	11
Mississippi River	77	2790.7	62
Missouri River	9	131.2	5
Mobile River	4	380.5	4
Monongahela River	1	N.A.	0
Ohio River	34	704.1	29
Ouachita River	4	71.6	4
Pearl River	2	122.7	2
Tennessee River	20	449.6	9
TOTAL	199	$ 5297.95	155

Source: _1977 Waterside Plant Locations and Expansions_, The American Waterways Operators, Inc., November 1978.

of waterfront facilities.

This scenario will be played out against the "traditional infrastructure-oriented approach of government to transportation," as it was characterized in the Statement on National Transportation Policy (1971). The established pattern of Federal and local responsibilities has served the nation well. To make it work effectively in an era when open-minded construction programs are no longer feasible on the landside of the river, as well as in the channels and harbors, is the challenge of the next decade.

PUBLIC PERCEPTIONS OF INLAND WATER TRANSPORTATION

Although shallow-draft water carriage on Mid-America waterways is probably the nation's most efficient freight transportation service, it leads an industry that suffers from a low level of public visibility and some gross public misconceptions regarding its operations, facilities and economic performance. To begin with, there is little public appreciation of the industry's size -- more than 4,000 towboats and almost 27,000 barges moving more than 637 million tons of cargo annually on the nation's 15,000 miles of navigable waterways. A public that is unaware of the phenomenal growth in the volume of waterborne freight in the last decade can scarcely be expected to appreciate the restraining effect of low rates for water carriage on the economy's inflationary fever.

One of the odd views frequently encountered outside the industry attributes the increased volume of waterborne freight movement to diversion from other surface modes. Actually the growing volume of freight transported by all modes is essentially a function of national economic growth. Expansion of waterside industrial facilities in particular has given rise to a growing volume of freight moved by all modes.

CHAPTER 10

TRANSPORTATION SYSTEMS

This chapter examines the present and projected ability of locks and dams, railroads and pipelines to accommodate projected traffic demands.*

Locks and dams are of primary concern in this study and between the present and the year 2000, 13 locks are identified as future constraints upon the waterways' ability to move cargo; a brief discussion of the methodology employed in estimating lock capacity is presented. Railroads are examined with respect to present capacity and utilization, and potential future mainline constraints. Projections and proposals relevant to the pipeline industry are covered in the final section of the chapter.

LOCKS AND DAMS

An order-of-magnitude estimate of the capacities of all locks on the inland waterway system was made. Once these capacities were estimated, projected unconstrained waterborne traffic flows were compared with the capacities to identify the constraining locks.

There are 157 locks within the study area. The initial step in the capacity analysis was the identification of "potentially constraining" locks. To do this, rough estimates of lock capacity were developed for all 157 locks utilizing information obtained from two sources: (a) the Inland Navigation Systems Analysis (INSA) study being performed under contract to the Corps of Engineers, Office of the Chief Engineer, and (b) the responses provided to a TAMS questionnaire by the District Engineers in the study area. Based on a comparison of capacity and current waterborne commodity volumes, and taking into consideration projected traffic growth, 22 locks were identified as being current or potential constraints.

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* Unlike rail and pipeline, trucks are not generally viewed as competitive with the waterways, but complimentary to inland port operations; trucks are rarely used for long-haul movements of bulk commodities. Hence, they are not analyzed in this study.

In the next phase of the analysis, the capacity estimates of these 22 locks were refined. The lock capacity methodology described herein was applied to all potentially constraining locks for which Corps of Engineers Performance Monitoring System (PMS) data were available, specifically average tonnage per lockage and lockage time. The latter data were obtained for 16 of the 22 locks; for the remainder, estimates prepared by the Corps were utilized.

Where the methodology was applied, a 90 percent utilization factor was used as the basis for establishing practical capacity; that is, the lock will be used up to 90 percent of the time it is available for service. In comparison, the theoretical capacity of a lock assumes that it will be operated at a 100 percent utilization factor.

Constraining Locks

The 13 locks identified as constraints are noted in Table 10-1 and Figure 12. The table also shows estimated annual capacity, the year each lock reaches capacity, and the actual 1976 waterborne tonnage through the lock. The Illinois Waterway with seven locks reaching capacity during the forecast period is the most severly constrained waterway in the study area. The Intracoastal Waterway with three locks reaching capacity, is the second most constrained system. The Tennessee, Ohio and Mississippi Rivers each have one constraining lock.

On the Ohio River, improvements underway or firmly programmed to L&D 50, L&D 51, and L&D 53 will eliminate potential capacity constraints.

L&D 26 has been studied extensively by the Corps and it was deemed appropriate in this instance to use the

TABLE 10-1

CHARACTERISTICS OF CONSTRAINING LOCKS

Waterway	Lock and Dam	Tons (Millions) Estimated Annual Capacity	Tons (Millions) 1976 Waterborne Demand [1]	Year Capacity Is Reached
Illinois	Marseilles	32	25.8	1983
	Starved Rock	36	27.2	1985
	Brandon Road	32	23.1	1989
	Dresden Island	35	25.4	1989
	Lockport	33	22.5	1992
	Peoria	57	33.2	1994
	LaGrange	59	30.7	1998
Tennessee	Kentucky	31	21.8	1991
Ohio	Gallipolis	47[2]	33.8 (1975)	1996
Mississippi	L&D 26	73[3]	54.5	1984
Gulf Intracoastal	Inner Harbor	30	30.4	Current
	Port Allen	30	20.2	1993
	Vermilion	45	40.3	1996

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[1] Two-directional, based upon U.S. Army Corps of Engineers, Waterborne Commodity Statistics.

[2] Practical capacity estimate prepared by Corps of Engineers.

[3] Practical capacity estimate prepared by Corps of Engineers, assumes use of switch boats.

Corps estimate of capacity; the demand through the lock; however, is the Mid-America estimate.

Studies performed by other public agencies have identified, in one form or another, other locks which, by the year 2000, may have potential capacity problems. Without passing judgment on the reasonableness of these other findings, it is apparent that the very nature of the forecasting process and the assumptions underlying the forecast itself leave room for divergence. Another study's findings cannot be compared directly to the Mid-America analysis without taking full account of the assumptions used in this study for measuring the impact of waterway user charges, western coal movements, new waterway projects and future energy policy.

Capacity Methodology

The capacity of a waterway is dictated by either a lock or a constricted reach. On those waterways with locks, the instances where channel dimensions are the controlling factor are few and, accordingly, are not considered in this study.

Two different concepts of tonnage capacity are involved in the analysis. The maximum theoretical capacity of a lock is defined as the annual tonnage that can pass through a lock assuming: (a) that all tows are of the maximum size and draft that can negotiate the lock; (b) tows will always be waiting at either end of the lock so that there will be continuous lockages; (c) each lockage takes the minimum lockage time; and (d) lockages occur 24 hours each day of the year. These idealized conditions can never exist, inasmuch as they prohibit empty or partially loaded barges; barges loaded with light-weight (low specific gravity) commodities; lockages for recreational craft; and stoppages in lock operation due to adverse weather conditions or maintenance work. Also, under a condition of 100 percent utilization the delay times for barges waiting in line to pass through the lock would become excessive and traffic would divert to other modes of transportation. The maximum theoretical capacity is a hypothetical value which simply serves as a measure of a lock's physical dimensions and operational characteristics.

A more significant concept is practical tonnage capacity, defined as the greatest tonnage that can be moved through the lock before the delays experienced result in costs which exceed the cost of movement by some other route or mode, assuming that capacity is available on the alternative route or mode. The practical tonnage capacity of a lock is based, among other things, on the commodities that are available for transport on the waterway being considered. Two locks with the same physical dimensions and operational characteristics located on different waterways will not have the same practical tonnage capacity because the predominant traffic through one lock may be a heavy material such as ore while the commodities moving through the other may be of lighter weight such as grain.

Practical tonnage capacity depends, also, on the total waterborne transport cost and the costs of competing alternative modes of transportation. When delays at the locks become so great that the transport cost by water exceeds that of a competing mode, traffic will shift, provided capacity on the competing mode is available. There are a number of economic factors (which differ for each commodity) involved in the total transport cost by waterway and its competing modes. The exact point where increasing delay costs will constrain the use of a waterway cannot be determined accurately.

The capacities of the 22 locks identified as "potentially constraining" were evaluated using the following equation. Practical annual capacity, measured in tonnage, is:

$$C = (1440/L) \times U \times T \times I \times O, \text{ where:}$$

C = Annual tonnage,
L = Average Locking Time (minutes),
U = Utilization Factor,
T = Average tonnage per lockage,
I = Reduction Factor (for two chamber facilities),
O = Number of operating days per year.

Forecast commodity flows through each of the 22 potentially constraining locks were compared to capacities estimated in the above fashion to arrive at a determination of constraint status.

Following is a discussion of the factors used in the above equation.

> Average Tonnage Per Lockage. The average tonnage per lockage depends upon: (a) the average number of barges per lockage, (b) the percentage of full and empty barges, and (c) the average tons per loaded barge. The factors that affect these parameters include: lock size, types of commodities transported, type of tow equipment, average size of barges, size of the average tow, and number of recreational and other craft requiring lockage. The average tonnage per lockage was determined from historical PMS data at the lock.
>
> Average Lockage Time. Lockage is not simply the elapsed time that a tow actually occupies a lock chamber. Lockage time includes approach, filling (emptying) and departure time. The approach and departure times are significant portions of the lockage time. At some locations, conditions in the channel have more of an effect on lockage time than the actual filling or emptying operation.
>
> Utilization Factor. Without detailed studies of transport costs for each commodity by all modes, there is no method of determining the exact point where delay costs through a lock will constrain traffic growth. However, "queuing theory" provides an indication of how large delay times can become as the utilization of a lock increases, where utilization is defined as the percent of total time the lock is in actual use.

Figure 13 shows the relationship between average waiting time and lock utilization, based on a Poisson (random) arrival pattern and an exponential distribution of service (lockage) times for a single chamber lock and a double chamber lock. As noted in the Figure, the average waiting time as a multiple of average lockage time becomes asymptotic when lock utilization approaches 80 to 90 percent. The rapid increase in average waiting time is illustrated by the following: For an assumed average lockage time of 45 minutes at a single chamber lock the average waiting times for utilizations ranging from 75 to 98 percent increase from about two hours to 36 hours.

Therefore, on the basis of Figure 13, it is reasonable to assume that as lock usage approaches 90 percent of total available time, shipments will start to shift from waterway to alternative modes of transportation. This does not mean that such a shift will be sudden and absolute. Many factors will influence when, what commodities and how much cargo is lost to competing modes. A priority system for lockages and the cost structures of alternative modes are examples of such factors. Suffice it to say that some shipments will be lost to alternative modes as lock usage approaches 90 percent of total available time. The appropriate utilization factor depends upon whether the lock in isolation is a severe constriction or whether the lock is among a series whose capacities are in balance, where the delays at any one lock may be moderate but in total are excessive.

The implications of a 90 percent utilization factor are worth exploring, insofar as it provides a picture of the conditions at a lock when capacity is reached and diversion begins to occur. For a single chamber lock, as shown in Figure 13, average tow waiting time at 90 percent utilization is about nine times average lockage time. On the Illinois Waterways, this would amount to an average delay of about nine hours per lock.

More significant than average, however, is the distribution of waiting time for tows at L&D's with a capacity constraint. This is shown in Figure 14. For a large number of tows, the probability of incurring a given amount of delay equals the percentage of tows incurring that delay. For a single chamber L&D at 90 percent utilization, 10 percent of the tows will incur a delay of 23 hours or more (for a 1-hour lockage time); similarly, five percent of the tows will incur delays of 28 hours or more. Given these tow delay levels, the use of a 90 percent utilization factor for computing practical capacity appears reasonable for use in this study.

It is assumed that diversion of traffic begins at the point in time when practicable capacity is reached and that all traffic in excess of this capacity will be diverted. It is more likely that diversion will begin to occur before practical capacity is reached and that the level of diversion will increase as demand approaches capacity. This is borne out, in part, by the curves in Figure 14 which show that even at utilizations below 90 percent, a certain percentage of the tows will incur excessive delays.

When two lock chambers operate side-by-side, the traffic through one lock interferes with traffic through the other. Therefore, if the two chambers are of equal dimensions, the capacity will be somewhat less than double the capacity of a single chamber lock. Reported experiences have shown that the capacity of the second chamber should be reduced by amounts ranging from 25 to 50 percent.

RAILROADS

This section describes the analysis of the study area's rail facilities in terms of mileage and number of tracks, signal systems, traffic flow, capacity and utilization. For this analysis, railroad maps and data published by the Federal Railroad Administration were utilized.

Present Capacity and Utilization

For each of the subregions covered in the study the following data were collected:

1) the name of the operating railroad;
2) miles of mainlines;
3) designation of tracks (single and multiple);
4) type of signalling system (no signals, automatic block system or centralized traffic control);

5) traffic density; and
6) direction of rail system (east/west or north/south).

From actual traffic volumes, and the capacity of the track facilities, utilization factors were determined. Table 10-2 summarizes the rail system capacities used in this analysis.

TABLE 10-2

RAIL SYSTEM CAPACITIES
(millions of GTM per year)

	Single Track	Multiple Track
No Signals	10	30
Automatic Block	27	93
Centralized Traffic Control	53	127

Source: Final Standards, Classification, and Designation of Lines of Class I Railroads in the United States, DOT; January 19, 1977.

Table 10-3 and Figure 15 provide a summary of the capacity utilization of rail system and intensity of rail facilities in the subregions; Table 10-3 also shows percentages of the rail system that are (a) multiple track and (b) signalled.

The rail lines operating in east/west direction in the study region had a utilization factor of 36 percent, while those operating in north/south utilized 40 percent of their capacity. The utilization rates among the states comprising the region varied considerably. The lowest utilization of 19 percent was by the rail lines in Oklahoma (north/south) and the highest (59 percent) by the lines in Alabama (north/south). In 15 out

TABLE 10-3

CHARACTERISTICS AND CAPACITY UTILIZATION OF RAIL MAINLINES IN THE STUDY REGION

	North/South						East/West					
	Miles of Rail Main Lines	Mileage with Multiple Tracks (%)	Mileage Signalled (%)	Traffic (GTM)	Capacity (GTM)	Utilization (%)	Miles of Rail Main Lines	Mileage With Multiple Tracks (%)	Mileage Signalled (%)	Traffic (GTM)	Capacity (GTM)	Utilizaion (%)
Alabama	866	2%	41%	14,938	25,821	59%	1,032	1%	89%	18,206	37,574	48
Arkansas	744	3	90	16,634	35,794	46	969	10	76	16,274	39,442	41
Illinois	2,085	34	67	47,345	42,260	42	2,597	39	82	53,522	165,693	32
Iowa	902	0	55	7,028	19,533	36	1,864	35	85	29,179	111,399	26
Kansas	538	0	78	8,885	18,986	47	525	41	100	12,406	32,939	38
Kentucky	768	36	100	21,653	52,480	41	527	25	96	9,135	27,560	33
Louisiana	780	6	54	11,490	22,322	51	740	0	42	7,801	16,469	47
Minnesota	946	18	83	16,061	40,324	40	172	0	88	2,355	7,476	32
Mississippi	1,105	8	32	12,732	26,998	47	175	0	11	1,314	2,610	50
Missouri	1,224	8	74	17,725	48,325	37	1,604	20	93	28,853	87,580	33
Nebraska	226	0	27	2,118	3,800	56	612	26	92	14,118	31,962	44
Ohio	1,178	39	67	29,946	72,790	41	1,426	51	86	36,824	93,892	39
Oklahoma	825	100	90	15,435	80,319	19	496	0	54	5,730	13,936	41
Pennsylvania	744	42	74	18,948	42,831	44	820	51	75	23,371	58,305	40
Tennessee	824	10	83	19,070	38,652	49	518	27	64	11,088	22,787	49
West Virginia	394	39	61	9,786	22,090	44	736	63	82	19,873	53,368	34
Wisconsin	356	57	100	9,413	23,270	40	508	32	81	7,170	26,769	27
Total	14,505	23%	69%	279,207	616,595	40%	15,320	29%	81%	297,219	829,760	36%

Source: Temple, Barker & Sloane, Inc.

of the 17 states, the rail lines operating in north/south direction had higher capacity utilization as compared to the lines operating east/west. The exceptions were in the states of Mississippi and Oklahoma.

Analysis of Potential Future Mainline Railroad Constraints

Using the 1976 Traffic, Capacity and Utilization of Rail Facilities as a baseline, an analysis identifying potential constraints in the rail network was performed. The methodology employed was an extension of that developed for the Rail Facilities Analysis.

Identification and Upgrading of Mainline Rail Constraints

The mainline railroad constraint occurs when demand for ton-mile utilization of a subregion's mainline track exceeds 100 percent of its capacity. The capacity of the mainline within each subregion and for north/south (N/S) and east/west (E/W) was determined using the methodology outlined in the Rail Facilities Analysis segment. The historical 1969-1976 growth rate of major railroads operating in the Mid-America Region was 1.9 percent. This annual increase served as the basis for forecasting growth in the demand for railroad ton-miles of transportation. An additional, more conservative determination was performed based upon an annual increase in traffic of 2.85 percent per year, 50 percent greater than the historical rate. This more rapid growth rate yields a doubling of rail traffic in 24 years.

These scenarios expand rail traffic at rates that imply rail utilizations in excess of 100 percent for subregions with 1976 utilization of 64 percent for the 1.9 percent growth rate and 50 percent for the 2.85 percent growth rate. Table 10-4 lists the 25 subregions that would be potentially constrained in the year 2000 if their traffic were to expand at a rate of 1.9 percent annually. Approximately 10 percent of

TABLE 10-4

POTENTIAL MAINLINE RAIL CONSTRAINTS BY YEAR 2000[1]
(millions of gross ton-miles)

									Automated Block Upgrade[2]			Centralized Traffic Control Upgraded[3]			
State	Subregion	Direction	Track Miles	1976 Volume	1976 Capacity	Percent 1976 Utilization	Percent Multi Track	Percent Signaled	Revised Capacity	Revised Utilization	Notes	Revised Capacity	Revised Utilization	Notes	Miles Improved
AL	012	N/S	223	2,663	3,778	70	0	16	6,962	38%		11,832	23		187
	015	N/S	164	3,815	5,936	64	0	71	6,749	56%		8,794	43		47
	017	N/S	63	1,345	1,701	73	0	100	3,339	40%	All track is automated block, upgrade to centralized.	3,339	40		63
ARK	044	N/S	9	3,150	4,770	66	0	100	4,770	66	All track is centralized system. No upgrade feasible.	4,770	66		0
	047	N/S	47	353	470	75	0	0	1,269	37		2,491	14		47
ILL	131	N/S	51	383	510	75	0	0	1,377	28		2,703	14		51
	132	N/S	65	750	1,040	72	0	19	19,35	39		3,304	23		53
	137	E/W	65	488	650	75	0	0	1,755	37		3,445	14		65
KY	179	N/S	40	1,400	2,120	66	0	100	2,120	66	All track is centralized system. No upgrade feasible.	2,120	66		0
LA	181	N/S	82	1,230	1,551	79	0	21	2,652	46		4,336	28		65
	188	N/S	347	4,380	5,476	80	0	34	9,369	47		19,216	23		229
	183	E/W	13	98	130	75	0	0	351	28		689	14		13
	184	E/W	60	450	600	75	0	0	1,620	28		3,180	14		60
	185	E/W	60	450	600	75	0	0	1,620	28		3,180	14		60
	186	E/W	105	1,575	1,900	83	0	48	2,828	56		5,176	30		55
	187	E/W	30	225	300	75	0	0	810	28		1,590	14		30
MISS	242	N/S	20	150	200	75	0	0	540	28		1,060	14		20
	243	N/S	302	3,465	4,310	80	0	10	8,930	39		15,997	22		272
	246	N/S	50	375	500	75	0	0	1,350	28		2,650	14		50
	241	E/W	95	713	950	75	0	0	2,565	28		5,035	14		95
	245	E/W	35	263	350	75	0	0	945	28		1,855	14		35
MO	253	N/S	133	2,765	4,241	65	0	100	5,797	48	Ave. capacity 42 grt-mile 55% centralized, 45% automated, upgrade all automated.	5,797	48		60
OH	352	N/S	30	225	300	75	0	0	810	28		1,590	14		30
	353	N/S	67	503	670	75	0	0	1,809	28		3,551	14		67
WV	484	N/S	44	548	680	81	27	0	1,428	38		2,572	18		44
AVERAGE WEIGHTED UTILIZATION						72.6				43			26		1,698

[1] Assumes annual ton-mile growth at 1.9 percent per year (1969-1976 rate). Includes only subregions showing a minimum of 64 percent utilization in 1976 which implies a potential 100 percent utilization in 2000.

[2] All improvements made to non-signal single track. Upgrade is installation of automated block system unless otherwise noted.

[3] All improvements made to non-signal single track. Upgrade is installation of centralized traffic control.

Notes

N/S: North/South Mainlines.
E/W: East/West Mainlines.

Source: Temple, Barker & Sloane, Inc.

the 1976 north/south traffic and 1.5 percent of the east/west traffic faces constraint by the year 2000 under these assumptions.

Analysis of Potential Future Mainline Constraints With Upgrading

Those subregions faced with potential constraints were each examined under two alternatives of facility upgrading. In both cases, the upgrading consisted entirely of improving mainline capacity by installing rail traffic control systems along existing unsignalled single track mainlines. Figure 16 outlines the methodology of upgrading capacity that was used to improve potentially constrained subregions

The effect of upgrading potentially constraining mainlines by the addition of automated block systems and the more current and effective centralized traffic control system is presented in Table 10-5. Installation of either traffic control system will increase mainline capacity to meet demand through the year 2000 in all but two subregions: 044 N/S in Arkansas (Helena vicinity) and 197 N/S Kentucky (Barkley Lock and Dam vicinity on the Cumberland River). Both subregions' mainline traffic is currently directed by centralized traffic control systems and no upgrade is therefore feasible. Both subregions could experience 103 percent utilization in the year 2000. This would be only marginally in excess of capacity and it is expected that relief would come from the use of alternative mainline routes or future development in the efficiency of in-place traffic control systems during the remainder of the century.

Table 10-5 presents the analysis of an additional 22 subregions identified as potentially constrained by 2000 under the more conservative 2.85 percent annual traffic growth scenario. The 22 subregions were similarly relieved by automated block and

TABLE 10-5

ADDITIONAL POTENTIAL MAINLINE RAIL CONSTRAINTS BY YEAR 2000[1]
(millions of gross ton-miles)

								Automated Block Upgrade[2]				Centralized Traffic Control Upgrade[3]			
State	Subregion	Direction	Track Miles	1976 Volume	1976 Capacity	1976 Percent Utilization	Percent Multi Track	Percent Signaled	Revised Capacity	Revised 1976 Utilization	Notes	Revised Capacity	Revised Utilization	Notes	Miles Improved
AL	014	N/S	242	2,515	4,740	53	6	17	8,154	31%		13,377	19		200
	018	N/S	105	2,875	5,565	52	0	100	5,565	52%	All track cen-. tralized block. No upgrade feasible.	5,565	52		0
	014	E/W	281	6,348	11,184	57	0	90	11,661	54%					
ARK	043	E/W	310	3,848	5,735	61	0	50	8,370	42		12,400	28		155
ILL	138	N/S	16	880	1,488	59	100	100	14,488	59	Nearly all track centralized system. No upgrade feasible.	14,488	59		0
	139	N/S	308	7,820	14,850	53	39	51	17,416	45		21,339	37		151
KY	170	N/S	65	2,775	4,445	62	38	100	4,445	62	Nearly all track centralized system. No upgrade feasible.	4,445	62		0
	173	N/S	125	5,375	9,565	56	36	100	9,565	56	Nearly all track centralized system. No upgrade feasible.	9,565	56		0
	173	E/W	50	600	1,010	59	0	60	1,350	44		1,870	32		20
LA	182	N/S	80	1,550	3,070	50	0	100	4,256	36	57 percent automated, 43 percent centralized. Upgrade automated to centralized.	4,256	36		0
	188	E/W	142	1,065	2,049	52	0	26	3,835	27		6,567	16		105
MISS	245	N/S	400	4,595	7,870	58	0	23	13,106	35		2,114	22		308
MO	255	N/S	205	2,125	3,844	55	0	31	6,249	34		9,926	21		141
OH	354	N/S	208	5,558	10,253	54	34	49	12,056	46		14,814	37		106
	352	E/W	72	1,080	1,944	56	0	0	3,168	34		5,040	21		72
TN	421	N/S	80	900	1,480	61	0	50	2,160	42		3,200	46		40
	423	N/S	167	4,132	7,750	53	0	97	7,835	53		7,965	52		5
	426	N/S	195	4,575	8,495	54	0	100	8,495	54	All track is automated block. No upgrade.	16,880	27		195
	422	E/W	266	5,620	10,306	55	30	65	11,889	47		14,309	39		93
	423	E/W	30	960	1,730	55	0	33	2,067	46		2,581	37		20
	424	E/W	163	2,633	4,686	56	0	54	5,960	44		10,160	26		75
WV	481	N/S	15	225	405	56	0	100	405	56	All track is automated block. No upgrade.	1,050	21		225
AVERAGE WEIGHTED UTILIZATION						55				42			34		1,911

[1] Assumes annual ton-mile growth at 2.85 percent (50 percent greater than 1969-1976 rate). Includes only subregions showing a minimum of 50 percent utilization in 1976 which implies a potential 100 percent utilization in 2000.

[2] All improvements made to non-signal single track. Upgrade is installation of automated block system unless otherwise noted.

[3] All improvements made to non-signal single track. Upgrade is installation of centralized traffic control.

Notes

/S: North/South Mainlines.
E/W: East/West Mainlines.

Source: Temple, Barker & Sloane, Inc.

centralized traffic controls installations along currently unsignalled single track. These five subregions are all currently projected to be constrained in the north/south direction and collectively account for less than six percent of 1976 north/south traffic. Of these subregions only one will experience demand in 2000 exceeding 110 percent. Table 10-6 presents the subregions facing constraints and identifies the affected region and the major railroads serving it.

Analysis of Rail Capacity Parallel to the Mississippi and Ohio Rivers

The ability of mainline railroads to absorb future rail traffic parallel to the Mississippi River and the Ohio River are currently experiencing traffic levels that impinge upon their ability to operate year-round without delays at key locks and dams that would divert traffic to the railroads.

Using the same methodology for rail utilization capacity, and upgraded capacity previously described, north/south tons/mainline mile along the east and west banks of the Mississippi River corridor and east/west tons/mainline mile along the Ohio River corridors north and south banks were determined.

Figure 17a presents the result of the analysis of the Mississippi River. Along both banks surplus capacity capable of absorbing a doubling in traffic is available with a minimum of control system upgrade. Peak activity in 1976 occurred below St. Louis along the Missouri and Illinois banks. Traffic totaled 50 million tons on mainlines with an ultimate capacity of 150 million tons. Waterborne traffic in this region was approximately 75 million tons.

As shown in Figure 17b, 1976 traffic along the Ohio River was greatest in the Wheeling, West Virginia area at approximately 55 million tons on mainline with an ultimate capacity of 150 million tons. Traffic along the Ohio between Evansville, Indiana and Pittsburgh is more consistently heavy than traffic along the majority of the Mississippi River.

TABLE 10-6

CONSTRAINED SUBREGIONS WITH UTILIZATIONS TO EXCEED 100 PERCENT DESPITE INSTALLATION OF CENTRALIZED TRAFFIC CONTROLS TO FORMERLY UNSIGNALLED SINGLE TRACK MAINLINE*

	Subregion	Direction	Location	Percent Utilization In 2000	Percent State Movements N/S	Major Rail Lines
			Subregions Constrained Under 1.9 Percent Annual[a] Growth Conditon*			
Arkansas	044	N/S	Helena Region (Mississippi River)	104	18.9	Missouri Pacific/St. Louis Southwestern
Kentucky	179	N/S	Cumberland River Outlet	104	6.4	Illinois Central
			Additional Subregions Constrained Under 2.85 Percent Annual Growth Conditions*			
Alabama	018	N/S	Chattahochee River Region	102	19	Seaboard Coast Line
Illinois	138	N/S	Cairo-Metropolis Region (Ohio River)	116	1.8	Illinois Central
Kentucky	170	N/S	Cincinatti-Ashland Zone (Ohio River)	110	12.8	Louisville And Nashville
	173	N/S	Cehna/Wolf Creek (Cumberland River)	110	24.8	Louisville and Nashville
Tennessee	423	N/S	Tennessee River Region	102	21.7	Illinois Central

*Subregions constrained with installation of centralized traffic control on all unsignalled single line track.

Source: Temple, Barker & Sloane, Inc.

Conclusions

The railroad mainline infrastructure serving the Mid-America regions is capable of absorbing increases in traffic to the year 2000 in all but a few locations. These few constraining mainlines within the rail network can be relieved by upgrading traffic control systems along the track or the diversion of traffic through nearby underutilized mainline segments.

Through track control and signal improvements to 15 percent of mainline track in the Mid-America Region, a doubling of rail traffic can be accommodated. The installation of state-of-the-art centralized traffic control systems costs approximately $50,000 per mile. The cost of upgrading the signal and control systems of the approximately 4,000 miles of mainline identified as being potentially constrained is estimated to be $225 million to be expended over the remainder of the century. This amount has been targeted by the railroads for some years and a significant portion of this sum has already been deferred as a delayed maintenance expense. Although this expenditure must compete for the limited capital budgets of most railroads, the amount constitutes less than six percent of the deferred maintenance and delayed capital expenditures of the mainline railroads that serve Mid-America, and less than 25 percent of the estimated railroad deferments within the region itself. Therefore, it is not expected that the waterways will benefit from any diversion from the railroads caused by railroad capacity mainline track constraints.

The importance of railroad freight yard operations constitutes yet another crucial factor in railroad performance. Historically, railroads have increased yard marshalling capacity by expanding the size of existing yards, building new yards, and introducing car identification and switching procedures. All of these activities have and will continue to be a significant portion of railroad capital budgets.

During the remainder of the century, railyard capacity is not expected to constrain traffic movements. Operational and technological investment is expected to continue. In addition, the increasing emphasis by railroads on unit train and large multi-car shipments will serve to reduce the relative requirements for marshalling. Such movements can frequently be routed around freight yards entirely.

PIPELINES

A review of present pipeline construction proposals indicates that they are predicated mainly on the development of new locations of natural resources. Production of petroleum and natural gas within the 48 contiguous states is expected to decline from the 1975 level with an anticipated increase from Alaska, off-shore locations, and foreign inputs. Major increases in the production of coal are expected to occur in the Mountain region.

Increases in the use of pipelines for transporting chemicals will depend on the growth in demand for anhydrous amonia, ethylene and propylene and whether competing modes can efficiently handle the growth. The consensus of the pipeline industry appears to be that additional pipeline construction will be needed and that there will be a small number of larger diameter, new projects with maintenance and possible replacement of older lines and probable modification of lines to carry different products than originally designed for.*

Natural Gas

The natural gas transmission system is the most extensive within the pipeline industry. Since natural gas pipelines are non-competitive with other modes of transportation, there is no need to present the proposals for future construction projects. However, where a proposal deals with the modification of an existing gas transmission line to carry crude oil or petroleum products which are competitive with other modes, these proposals are presented.

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* _Pipeline and Gas Journal_, Contractor Roundtable -- U.S. Construction Outlook, Vol. 233, No. 1, January 1976, p.18.

At the present time, two proposals, as shown in Figure 18, have been formulated. One is based on reversing the flow of an existing gas transmission line and modifying its components to accommodate the flow of Alaskan crude oil from Long Beach, California to Wichita Falls, Texas for further movement to the refining areas. This proposal is one of three possibilities connected with the movement of Alaskan crude. Although this proposal does not appear to impact Mid-America waterborne commerce, the second proposal may. This deals with the conversion of a major gas transmission line to accept petroleum product movements between Texas and south-central Florida; a recent article stated:

> "Florida Gas added that it asked the Federal Energy Regulatory Commission for permission to convert a 'substantial part' of one of its two natural-gas pipelines into a petroleum-products pipeline. The company said it estimated conversion costs at $125 million.
>
> The proposed pipeline would distribute gasoline, fuel oils, jet fuel and kerosene, without cutting back the state's natural gas supply, the company said." *

Crude Oil and Petroleum Products

With the depletion of oil reserves in the traditional southwestern area of the United States, the petroleum industry embarked upon an ambitious domestic oil exploration program. In this regard, the Alaskan North Slope developments have proved successful. Exploratory drilling is currently underway

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* The Wall Street Journal, New York, February 8, 1978.

in the Atlantic Outer Continental Shelf, particularly in the Georges Bank area, the Baltimore Canyon area, and the Blake Plateau area (see Figure 10). Exploration is expected to be completed within one to two years and, depending on the findings, commercial development of the areas will commence immediately thereafter. It is also anticipated that additional development will occur in the Gulf of Mexico, off the Texas and Louisiana coasts, and also along the coastline of California.

Petroleum development in Alaska is expected to increase significantly in the next 15 to 20 years to help offset the depletion of existing domestic sources. Major sources of oil are anticipated for areas outside the currently exploited Prudhoe Bay and Cook Inlet fields, such as Navy Petroleum Reserve 4, and in east-central and west-central portions of the State as well as offshore in the Arctic Ocean, the Bering Sea, and the Gulf of Alaska.

With the anticipated changes in flow patterns of movement due to modifications resulting from changes in source, crude oil and petroleum pipeline systems will be adjusted. The Central region (PADD3) will probably experience an increase in demand that will generate increased pipeline movements of crude oil flows from the South (depletion of oil reserves in this area segmented by Alaskan crude flows from the West). A corresponding increase in petroleum products flow is indicated from the South to the Central and East regions.

Figure 18 shows off-shore crude oil projects; possible routings of Alaskan crude from the West Coast, inland; and, a petroleum products pipeline from Texas to south-central Florida.* The petroleum products proposal and one of the three proposals for moving Alaskan crude oil are based upon conversion of a major gas transmission line.

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* National Transportation Trends and Choices (to the Year 2000), U.S. Department of Transportation, January 1977.

Coal Slurry

As noted in the introduction, major increases in the production of coal are expected to occur in the Mountain region (PADD4). One mode considered for transportation is the coal slurry pipeline. Potential routes are shown on Figure 18. Five pipelines are currently proposed in locations generally requiring long-distance movements. The proposals, as provided by the Slurry Transportation Association include:

- Nevada Power Company: 183 mile -- 22 inch line -- Kanab, Utah to St. George, Utah and Las Vegas, Nevada (12 million tons/year)
- Northwest Pipeline Corporation: 778 mile -- 30 inch line -- Gillette, Wyoming to Oregon (10 million tons/year)
- Houston Natural Gas Corporation: 1,100 mile -- 18 inch line -- Walsenburg, Colorado to Angleton Texas (with intermediate terminals in Amarillo, Muleshoe, and Temple, Texas) (15 million tons/year)
- Energy Transportation Systems: 1,030 mile -- 38 inch line -- Wyoming to Arkansas (25 million tons/year)
- Texas Eastern Transmission: 1,260 mile -- 42 inch line -- South-eastern Montana to Texas (21-38 million tons/year)

The fate of the coal slurry industry is tied directly to resolution of outstanding legislative, institutional, environmental and engineering issues. These issues must be resolved before any determinations can be made to proceed with construction. A recent report has presented salient summaries of the major issues, accordingly:

> "The few studies in which costs of construction and operation of slurry pipelines were investigated indicate that the length and the throughput volume critically affect the unit costs and the economic viability of a particular system. However, these studies typically fail to answer clearly crucial

questions regarding their assumptions concerning engineering design and specific routes to be followed.

Railroad interests argue that, if pipelines are allowed to capture the future growth in coal traffic, railroad revenues and profitability will be adversely affected. This would, in turn, impair the railroads' ability to attract needed investment capital. The railroads have further argued that the loss of revenues due to the diversion of coal traffic to the pipelines might result in rate increases for other commodities. Pipeline interests argue that pipeline construction will not result in a loss of coal business to the railroads; instead, only a modest sharing of enormous future growth will take place. It has also been argued that pipelines will offer previously absent competition for the railroads, to the ultimate benefit of the consuming public.

One of the most important unanswered questions of slurry pipeline construction concerns the availability and cost of water. Since slurry operations require large amounts of water, a guaranteed and inexpensive supply is necessary. The West recently experienced drought, for example, and opposition has developed to use of its watershed for slurry pipelines. Some studies have proposed recycling water the length of the pipeline or pumping water from the Missouri River to the Northern Plains states because the water may be unfit for human or agricultural use.

No significant construction has taken place on any of the proposed slurry pipelines noted above. For the longer length slurry lines, the major delay has been the inability of the pipeline companies to acquire rights-of-way, principally across railroad-owned lands. It was for this reason that eminent domain legislation for slurry coal pipelines was introduced in the Congress. In parallel, the pipeline interest have aggressively pushed for state eminent domain legislation. To date, eight states have eminent domain statutes, eleven states have legislation that may be interpreted as allowing the granting of eminent domain to coal slurry lines, and two other states are currently considering eminent domain legislation."*

Conclusions

Whatever the outcome of the above issues, it is doubtful that coal slurry pipelines will play a major role in the transportation of coal through approximately 1985 because of the lengthy lead times required for assembling rights-of-way, design and construction. It also appears that major competition will occur between the coal-slurry pipelines and the railroads and will be centered in the Mountain region (PADD4). On balance, beyond 1985, the impact upon the waterways resulting from possible pipeline construction is viewed as minimal.

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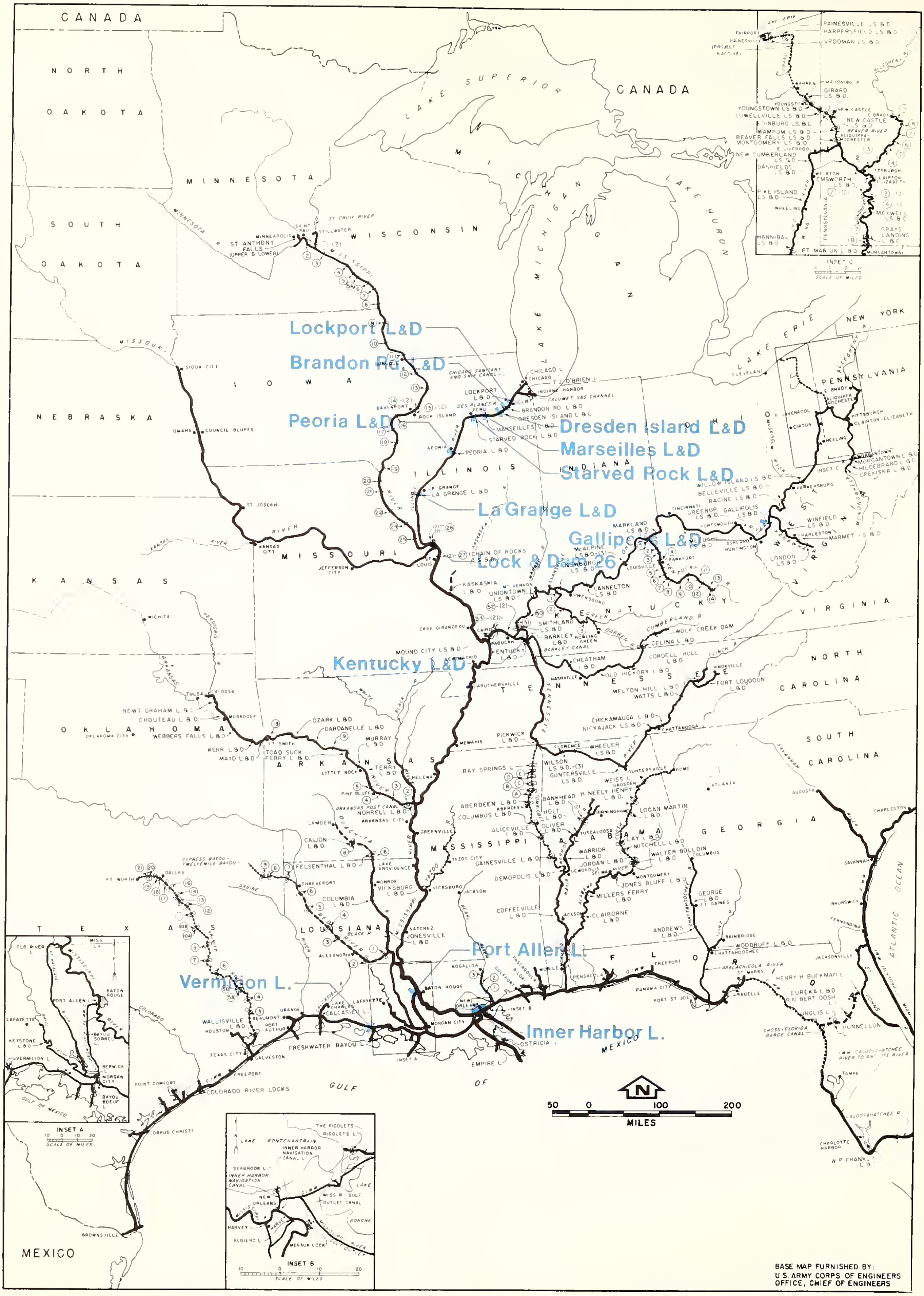
* Transporting the Nation's Coal - A Preliminary Assessment Report to the Secretary of Transportation from the Coal Transportation Task Force, U.S. Department of Transportation, January 1978.
The House of Representatives in 1978 rejected legislation which would grant eminent domain to coal slurry pipelines.


Lockport L&D
Brandon Rd. L&D
Peoria L&D
Dresden Island L&D
Marseilles L&D
Starved Rock L&D
La Grange L&D
Gallipolis L&D
Lock & Dam 26
Kentucky L&D
Port Allen L.
Vermilion L.
Inner Harbor L.
CANADA
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
WISCONSIN
IOWA
NEBRASKA
ILLINOIS
INDIANA
OHIO
MISSOURI
KANSAS
OKLAHOMA
ARKANSAS
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
LOUISIANA
TEXAS
WEST VIRGINIA
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
PENNSYLVANIA
NEW YORK
FLORIDA
MEXICO
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
GULF OF MEXICO
ATLANTIC OCEAN
INSET A
INSET B
INSET C
50 0 100 200
MILES
N

BASE MAP FURNISHED BY:
U.S. ARMY CORPS OF ENGINEERS
OFFICE, CHIEF OF ENGINEERS

FIGURE 12 CONSTRAINING LOCKS

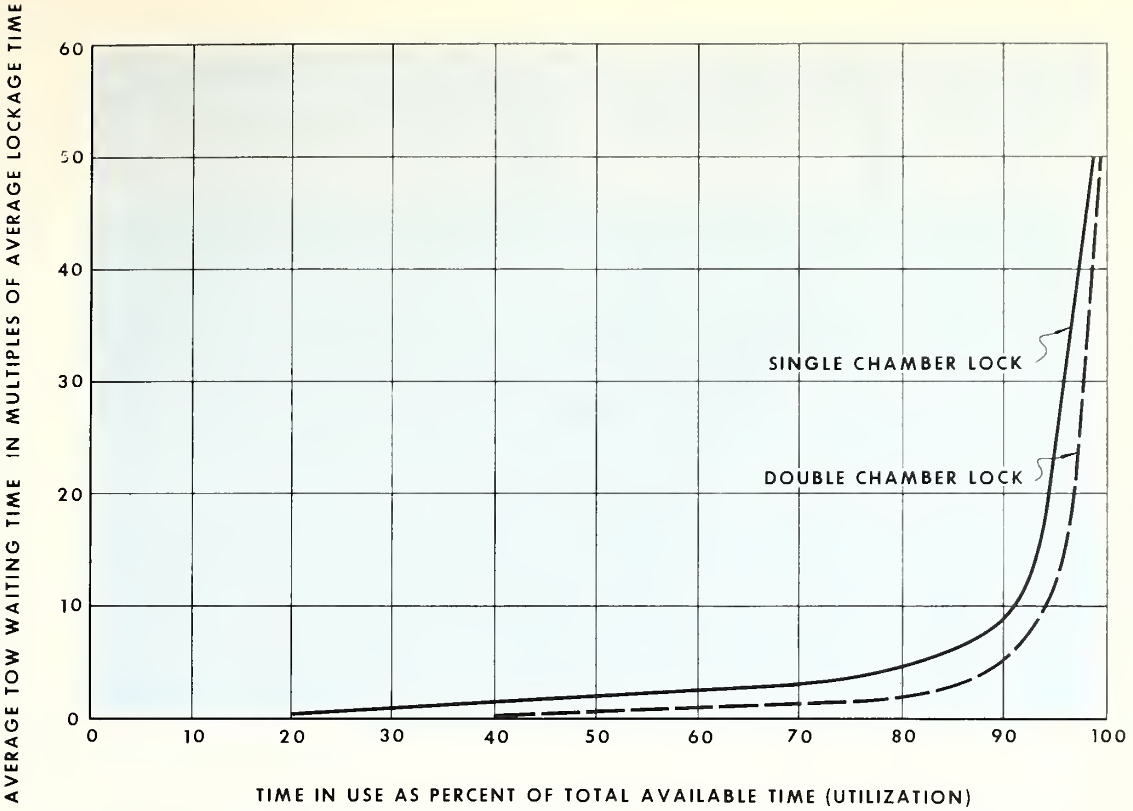


FIGURE 13 AVERAGE WAITING TIME

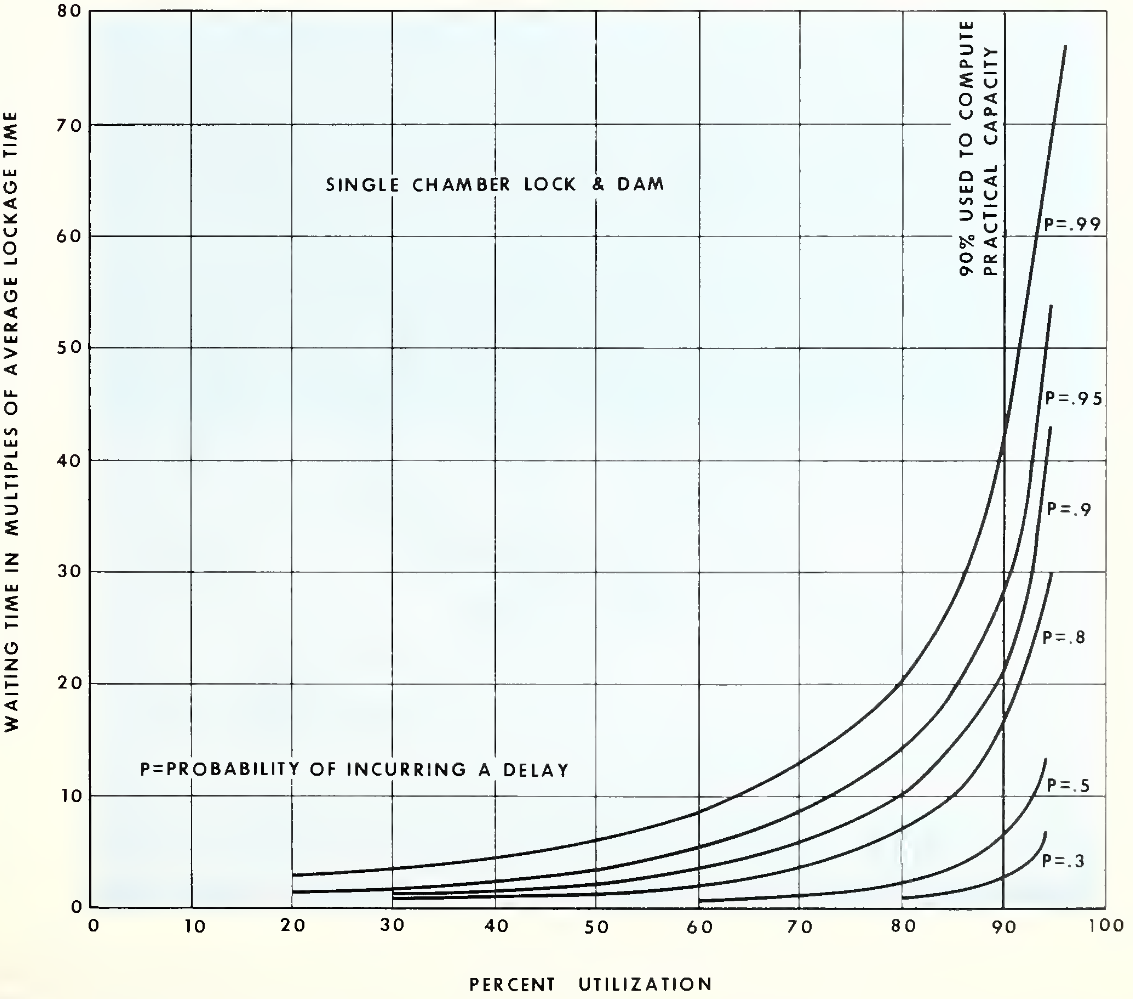
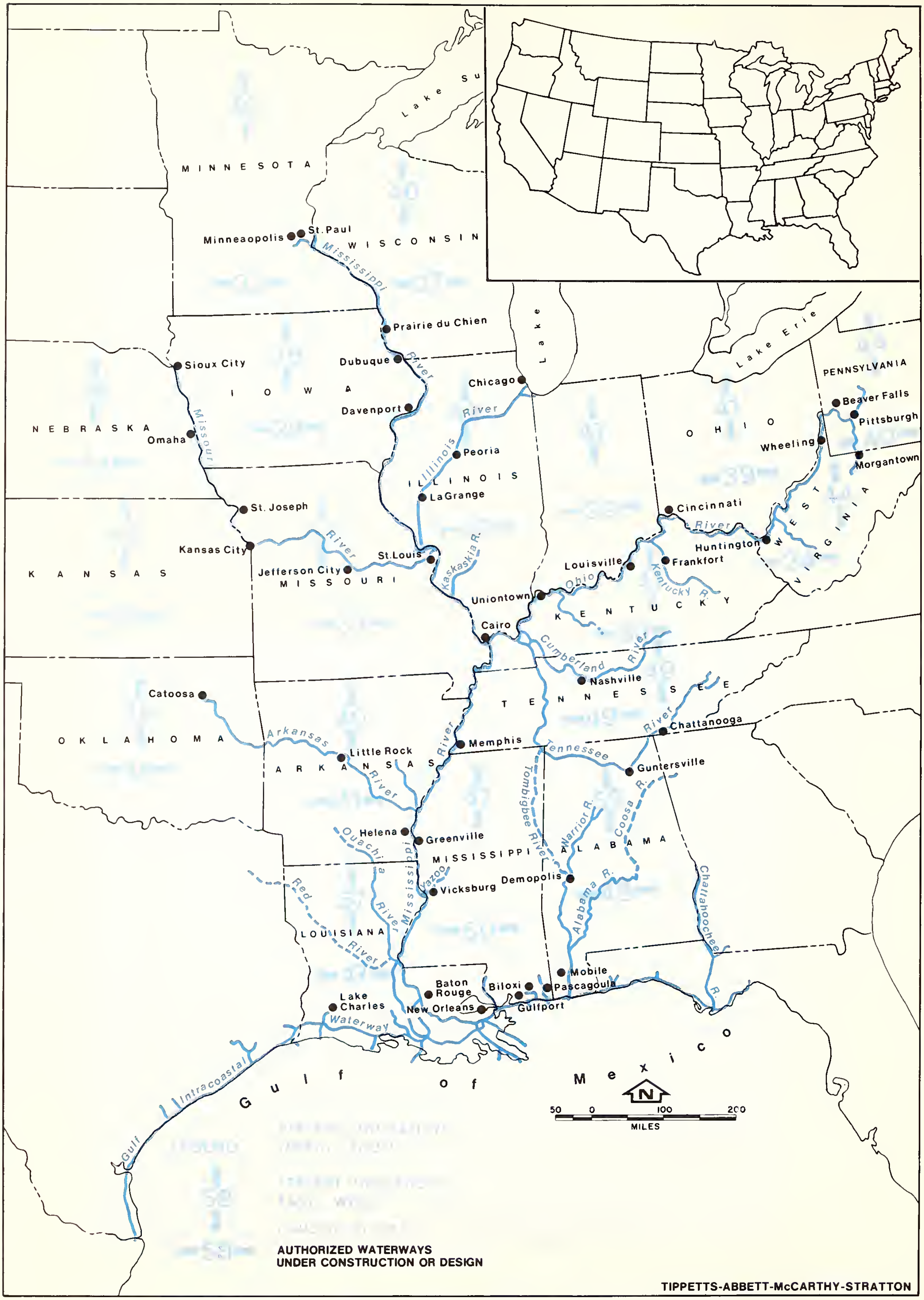


FIGURE 14 LOCK UTILIZATION


MINNESOTA
WISCONSIN
IOWA
NEBRASKA
KANSAS
MISSOURI
ILLINOIS
OHIO
PENNSYLVANIA
WEST VIRGINIA
KENTUCKY
TENNESSEE
OKLAHOMA
ARKANSAS
MISSISSIPPI
ALABAMA
LOUISIANA
Lake Superior
Lake Michigan
Lake Erie
Gulf of Mexico
Minneapolis
St. Paul
Prairie du Chien
Dubuque
Davenport
Sioux City
Omaha
St. Joseph
Kansas City
Jefferson City
St. Louis
Chicago
Peoria
LaGrange
Beaver Falls
Pittsburgh
Wheeling
Morgantown
Cincinnati
Huntington
Frankfort
Louisville
Uniontown
Cairo
Nashville
Chattanooga
Guntersville
Memphis
Catoosa
Little Rock
Helena
Greenville
Vicksburg
Demopolis
Mobile
Pascagoula
Biloxi
Gulfport
Baton Rouge
New Orleans
Lake Charles
Mississippi River
Missouri River
Illinois River
Kaskaskia R.
Ohio River
Kentucky R.
Cumberland River
Tennessee River
Arkansas River
Ouachita River
Red River
Yazoo
Tombigbee River
Warrior R.
Coosa R.
Alabama R.
Chattahoochee R.
Lake Charles Waterway
Gulf Intracoastal
N
50 0 100 200
MILES
AUTHORIZED WATERWAYS UNDER CONSTRUCTION OR DESIGN

TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 15 1976 UTILIZATION OF RAIL CAPACITY

PURPOSE:

To increase mainline capacity by adding (1) automated block and (2) centralized traffic control systems along currently unsignalled single track mainlines.

BASIC FORMULA:

New Capacity =

Old Capacity + Miles Mainline (1 - % Signalled) X Factor

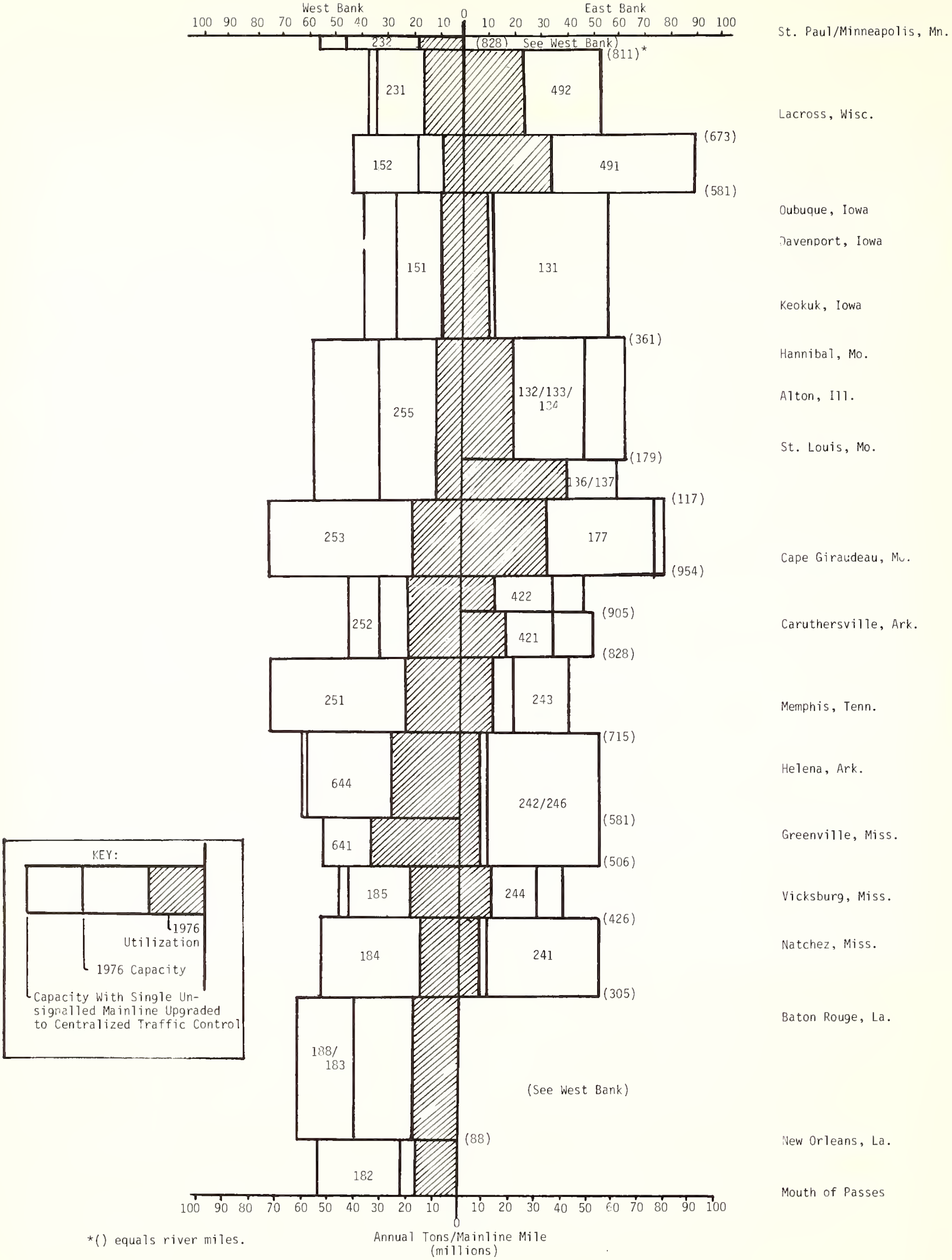
Factors:

1. 17m ton-miles/mile for unsignalled (10 mtm/m) upgraded to automated block (27 mtm/m).
2. 26m ton-miles/mile for automated block (27 mtm/m) upgraded to centralized traffic control (53 mtm/m).
3. 43m ton-miles/mile for unsignalled (10 mtm/m) upgraded to centralized traffic control (53 mtm/m).

Increase applies only to unsignalled track. All multiple track mileage is assumed to be signalled.

Factor 2 is only applied to those miles of automated block mainline identified by weighted analysis of mainline capacity and mileage.

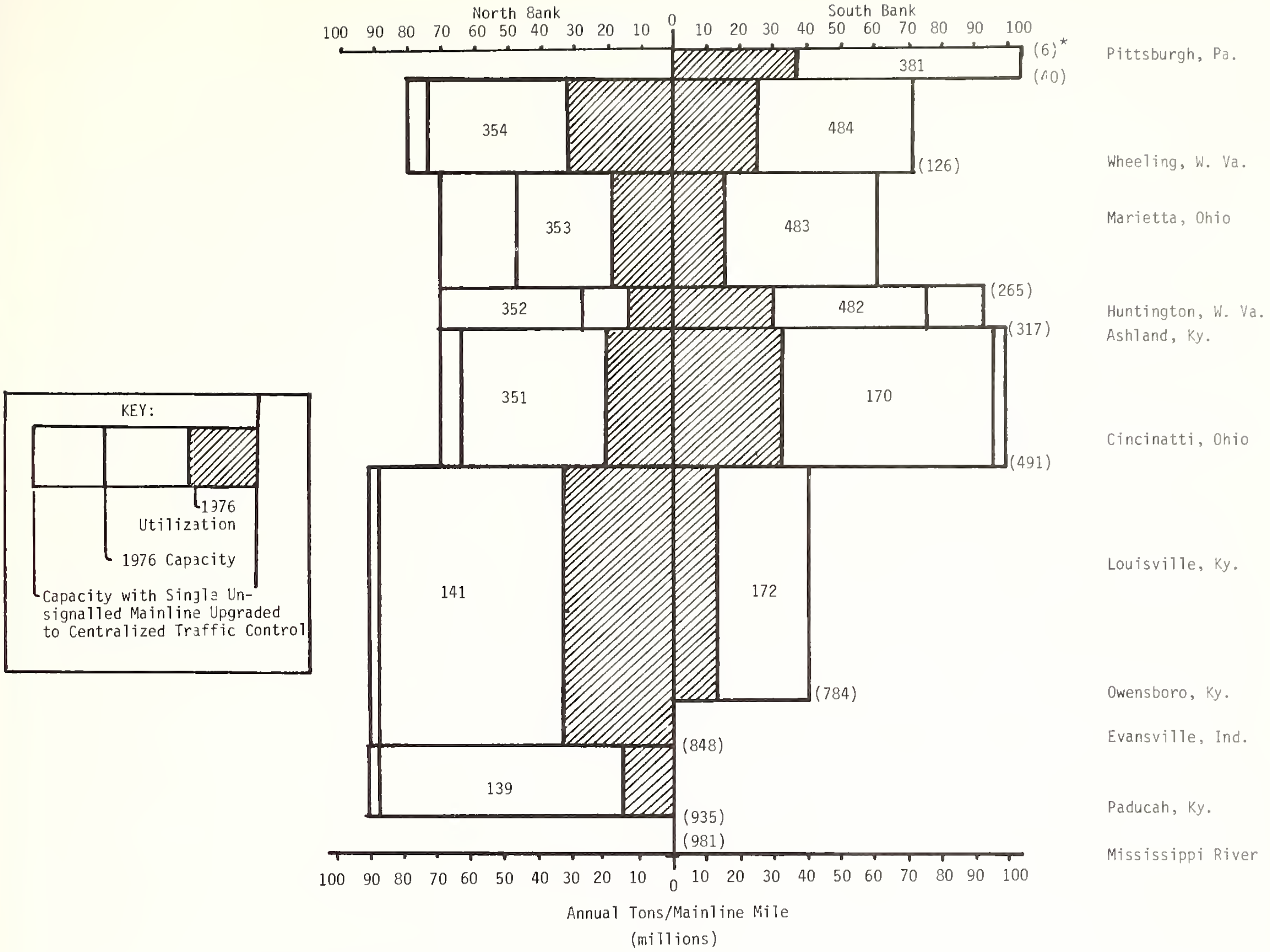
FIGURE 16 MAINLINE CAPACITY UPGRADE METHODOLOGY



*() equals river miles.

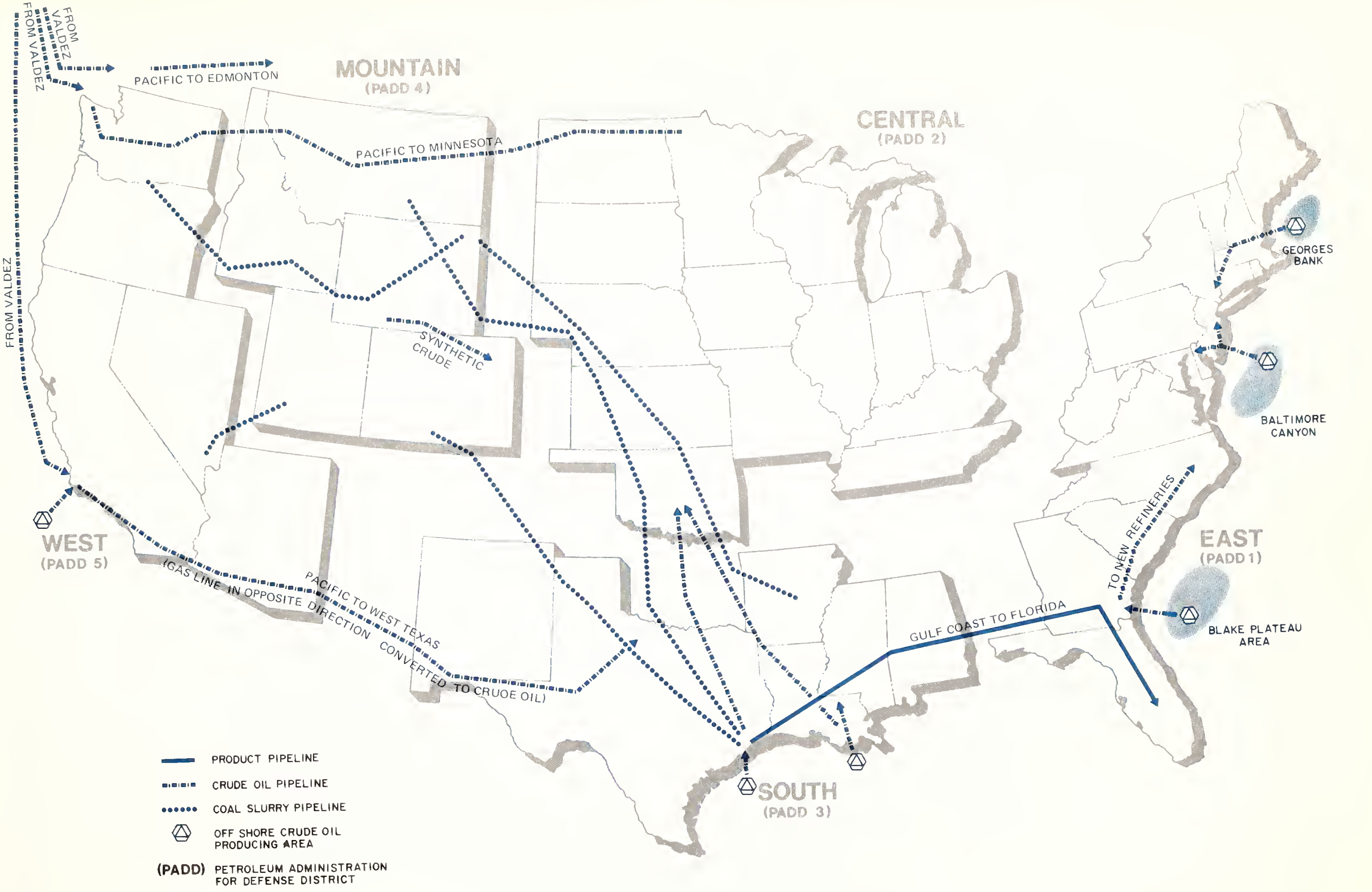
TEMPLE, BARKER & SLOANE

FIGURE 17 A MISSISSIPPI RIVER - RAIL UTILIZATION AND CAPACITY



*() equals river miles.

FIGURE 17 B OHIO RIVER - RAIL UTILIZATION AND CAPACITY


FROM VALDEZ
FROM VALDEZ
FROM VALDEZ
PACIFIC TO EDMONTON
MOUNTAIN
(PADD 4)
CENTRAL
(PADD 2)
PACIFIC TO MINNESOTA
GEORGES BANK
SYNTHETIC CRUDE
BALTIMORE CANYON
TO NEW REFINERIES
EAST
(PADD 1)
WEST
(PADD 5)
(GAS LINE IN OPPOSITE DIRECTION
PACIFIC TO WEST TEXAS
CONVERTED TO CRUOE OIL)
GULF COAST TO FLORIDA
BLAKE PLATEAU AREA
SOUTH
(PADD 3)
PRODUCT PIPELINE
CRUDE OIL PIPELINE
COAL SLURRY PIPELINE
OFF SHORE CRUDE OIL PRODUCING AREA
(PADD) PETROLEUM ADMINISTRATION FOR DEFENSE DISTRICT

SOURCE: NATIONAL TRANSPORTATION: TRENDS AND CHOICES, APPENDIX, U.S. TRANSPORTATION ATLAS

FIGURE 18 MAJOR PIPELINE PROPOSALS-1980

CHAPTER 11

FORECAST SHIPPING TECHNOLOGY

This chapter reviews future inland waterways fleet developments.

OPERATIONAL CONSTRAINTS

Technology on the inland waterways has been shaped by the characteristics of the rivers and has undergone a steady gradual evolution. Despite the developments that have taken place in past decades, the limitations of locks, river bends, and shallow water still dictate the form of inland navigation to a large extent. Because it is unlikely that these limitations will be significantly altered during the remainder of this century, gradual evolution rather than quantum leaps in technological development will continue. Table 11-1 presents towboat and barge developments introduced during the past three decades. These technological changes will not measurably affect the modal distribution of cargo flows.

Several recent forecasts of inland waterway technology have pointed to radical alternatives rather than feasible responses to the challenges currently facing river operators. These suggested alternatives have included sophisticated navigation and gas-turbine propulsion systems as well as the increased utilization of inter-modal systems, including the barge-carrying concept. The proposals are unlikely to be realized except on a limited basis. Indeed, it is unlikely that the adoption of any new technology will be successfully adopted unless it meets the following criteria.

- It is of almost universal application to inland fleet operations. Prospects include labor and time-saving lash-up systems, engines capable of operating on lower cost heavy fuels, and improved visual and radar-related navigational aids.

TABLE 11-1

DEVELOPMENTS IN TOWBOAT AND BARGE TECHNOLOGY: 1950-1980

	Towboats	Barges
Propulsion System	Fuel Efficient High Speed Diesels	
	Exhaust-Driven Turbocharging	
	Skin Engine Cooling	
	Reversing Gear Clutches	
	Optimized Nozzles	
	Tunneled Stern	
Control System	Turn-o-Meters Lever Steering Direct Engine Controls	Remote Controlled Bow Units
	Airfoil Rudders	
	Flanking Rudders	
Navigation and Communication Aids	Clutter-Free Radar	
	VHF, UHF, Telex (Hardcopy) Communications	
	Carbon-Arc Searchlights	
Hull, Hardware and Other	Optimized Hull Form	Rake and Box Hull Forms
	Rigid All Welded Longitudinally Framed Hulls	Improved Coatings and Foam Filling
	Double Bottom and Bilges	Elimination of Bottom Boards
	Improved Accommodations	Quick Access Manholes
	Molded Rubber Push-Knees	Improved Ratchets
	Improved Deck Hardware (Buttons, Chocks, Kevels, Ratchets, Cleats)	
	Air-powered Winches	

- It is consistent with the requirements for commonality and interchangeability.
- It is cost-effective.

DEVELOPMENT OF THE INLAND WATERWAY FLEET

The inland waterway fleet can be expected to develop in the following manner:

- Towboats will continue to be produced at a rate of between 90-110 vessels per year with an average horsepower (hp.) of about 4,000. Approximately 40 of these towboats will be exclusively major river line-haul towboats exceeding 1,000 hp. Between three and five towboats exceeding 10,000 hp. will be delivered annually. Scrappings, losses and foreign sales will increase slightly from 20,000 hp. at present.
- Towboat crew size will undergo only a slight reduction during the remainder of the century. Certain efficiencies will result from more efficient lash-up devices and the use of larger barges.
- Before the year 2000, the medium speed diesel engines will be used aboard lower Mississippi line-haul towboats.
- Bow boats will become increasingly dependable and common on line-haul integrated tows.
- The barge fleet will continue to be composed of deck, hopper and tank barges. Hopper barges of integrated box and rake configurations will continue to be produced for dry bulk unit-tows but at levels below peak 1975-1977 output. The tank barge fleet will grow slowly, primarily as specialized parcel compartments and cylindrical tank craft are delivered.

PROPULSION

Increased horsepower will be used selectively and like increased tow size does not guarantee an increase in the efficiency of river operations. Towboats and tows must be designed to meet operational requirements.

In general, operators engaged in long distance contract tows of grain, oils, coal, and selected commodity unit-tows and those performing the "for hire" long-distance movement of assorted tows of barges of different shapes, drafts and sizes will purchase towboats in the highest horsepower ranges.

The requirements of waterway terminals operations will dictate work and fleeting boat design. The dispersed location of many facilities, storage areas and fleeting areas, combined with strong river currents and high volumes of barge traffic will require shift and fleet boats to have higher horsepowers than at present so that barge handling operations can be expedited.

Towboats in excess of 12,000 hp. are not likely to operate on the inland waterways because:

- Triple screw vessels experience operational difficulties in narrow segments of the waterways. Narrow reaches cause the outboard propellers of triple screw towboats to draw on poor inflows of water and thus suffer from vibration and cavitation. These propellers are also subjected to increased damage by flotsam, bottom debris and grounding. These difficulties limit the number of propellers which can be provided per ship.

- The basic physics of propeller theory limits the horsepower a 10-foot diameter disc can absorb without excessive vibration, blade cavitation and thrust loss to approximately 4,000 hp.

- The standard 9-foot minimum channel depth, and thus the maximum propeller diameter, is not likely to be increased.

- Barge tow size on the Lower Mississippi is limited by river geography and not the need for horsepower in excess of 7,000 to 8,000. Negotiating river bends and maneuvering in mid-stream restrict tow size to approximately 40 barges.

BARGE CARRIERS

Despite delivery on only two 21,500 dwt barge carriers during the 1976-1980 period, the U.S. Gulf Coast fleet is projected to expand from 400,000 dwt in 1975 to some 845,000 dwt in 2000, an annual growth of three percent. This rate of growth represents a new stage in the life cycle of the barge carrier and is not a continuation of the nearly 50 percent annual early life cycle growth rate experienced in the Gulf between 1969 and 1975. Table 11-2 presents a forecast of U.S. Gulf Coast barge carriers by vessel size and deadweight.*

This modest three percent annual growth in barge carrier supply through 2000 will fall short of the expected annual growth in potential cargos.** Although the commodities of high potential represent a small portion of all Mississippi River system cargoes on a tonnage basis, their value is proportionately higher than the majority of commodities handled at most inland waterways ports. It is for this reason that many local waterway port interests are hopeful that LASH and SeaBee barges can corner a larger share of containerized high value cargoes originating in and destined for their hinterlands.

Given the absence of barge carrier fleet expansion, and the conversion of several LASH vessels into full containerships, the commitment of marine decision-makers to the barge-carriers concept falls short of that required to assure anything more than a gradual decline in the role of the barge carrier in inland waterway international trade.

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* U.S. Merchant Fleet Forecast of Vessels in U.S. Foreign Trade, Draft Final Report, Temple, Barker and Sloane, Inc., January 1978.

** Foreign trade on the Mississippi River grew at the rate of 10 percent annually between 1966 and 1975 (U.S. Army Corps. of Engineers).

TABLE 11-2

FORECAST OF ANNUAL BARGE CARRIER CAPACITY SERVING U.S. GULF COAST

1975-2000

Average Vessel Deadweight	1975	1980	1985	1990	1995	2000
29,800	-	1	1	1	1	-
38,400	3	3	3	3	3	1
44,000	9	9	13	13	15	18
Total Annual Capacity in Millions of Deadweight	2.110	2.900	4.270	4.440	5.270	5.330

Source: U.S. Merchant Fleet Forecast of Vessels in U.S. Foreign Trade, Draft Final Report, Temple, Barker & Sloane, Inc. January 1978.

CHAPTER 12

FUTURE CARGO HANDLING SYSTEMS

The objectives of this chapter are to summarize the status of current cargo handling capacities, project future technologies and arrive at a "design" handling rate which typifies future cargo handling concepts. This design rate is then used as the basis for the development of conceptual facility plans in a later chapter.

Future cargo handling systems may be retrofitted to existing terminal or be considered part of a new terminal. In addressing handling requirements, account was taken of:

- the commodity type, such as coal, rather than the general handling technique, such as solid bulks;
- the distinction between the loading and unloading of the commodity; and,
- the distinction between large and small facilities, to the extent such a distinction is justified by operating practices and geographical differences.

Three stages of cargo handling development were considered: present, potential and future. Present rates are based on using relatively well established methods and proven high level state-of-the-art technology; the latter would be the upper-capacity range of existing facilities reviewed in Chapter 8. Potential methods are those judged appropriate for the year 1990 and are based generally on highest performing equipment now in use. Future methods are based on reasonably likely developments in equipment and systems by the year 2000.

Small facilities have the greatest opportunity for improving upon handling capability, largely because the technology already exists, and higher performance will be governed primarily by investment. It is more difficult to improve handling capabilities at large facilities because they are in many cases already using costlier, more advanced methods and many of these methods are nearing inherent development limits.

The "design" handling rates used inthis study generally, though not necessarily always, reflect improvements possible by the year 1990. The year 1990 is used because it falls midway in the forecast period. As such, the handling rates are a compromise between the rather limited improvements possible by the year 1980 and the more ambitious upgradings likely by the year 2000.

SOLID BULKS

Coal handling rates, using current equipment are projected as follows:

	Typical Present Rate (tph)	Future Design Rate (tph)
Small Facilities		
Loading	300	500
Unloading	200	400
Large Facilities		
Loading	3000	5000
Unloading	2500	4000

Figure 19 shows coal handling, loading and unloading rates for a cross-section of existing facilities and a trend projection of future rates.

Ore handling rates using current equipment, but not including high capacity self unloaders are projected as follows:

	Typical Present Rate (tph)	Future Design Rate (tph)
All Facilities		
Loading	3500	5000
Unloading	2 at 1000	3000

The existing and projected handling rates for dry bulk fertilizers, non-metallic minerals (sand, gravel), bulk sugar and bauxite are summarized in Table 12-1.

GRAINS

Grain handling rates, using current equipment, are projected as follows:

	Typical Present Rate (tph)	Future Design Rate (tph)
Small Facilities		
Loading	400	700
Unloading	300	400
Large Facilities		
Loading	1200	2000
Unloading	1200	2000

Figure 20 shows grain loading and unloading rates for a cross-section of existing facilities and a trend projection of future rates.

LIQUID BULKS

A moderate increase in the liquid bulk cargo transfer rates are projected. A 25 percent increase in handling rates, made possible by increasing the working pressure of land systems and by the use of booster pumps, makes the design handling rates for small and large facilities 125 and 250 tons per hour, respectively.

GENERAL CARGO

The future will see the increasing importance of containerized commerce as ports around the world become better equipped to handle containers and as cargoes such as lumber and some bulks become more commonly shipped in containers. Containerization's inherent capital intensiveness will continue to encourage the replacement of many small general cargo

TABLE 12-1

SUMMARY OF DESIGN COMMODITY HANDLING RATES
(Short-Tons per Hour)

	Typical Present Handling Rate(s)		Design Handling Rate H	
	Load	Unload	Load	Unload
Grain - Small	400	300	700	400
Large	1200	1200	2000	2000
Ores				
Bauxite	3500	2000	5000	3000
Coal - Small	300	200	500	4000
Large	3000	2500	5000	4000
Liquid Bulks - Small	100	100	125 [1]	125 [1]
Large	200	200	250	250
Fertilizer	1800 [2]	1900 [2]	2000	1000
Break Bulk			25	25
Lumber Wood Prod.			100	100
Sugar	-	250-400	-	400
Molasses	14-42 [3]	14-56 [3]	56 [3]	56 [3]
Metal Products			75	75
Scrap Metal			60	60
Non-Metallic Minerals	75-1500	50-1500	600	400

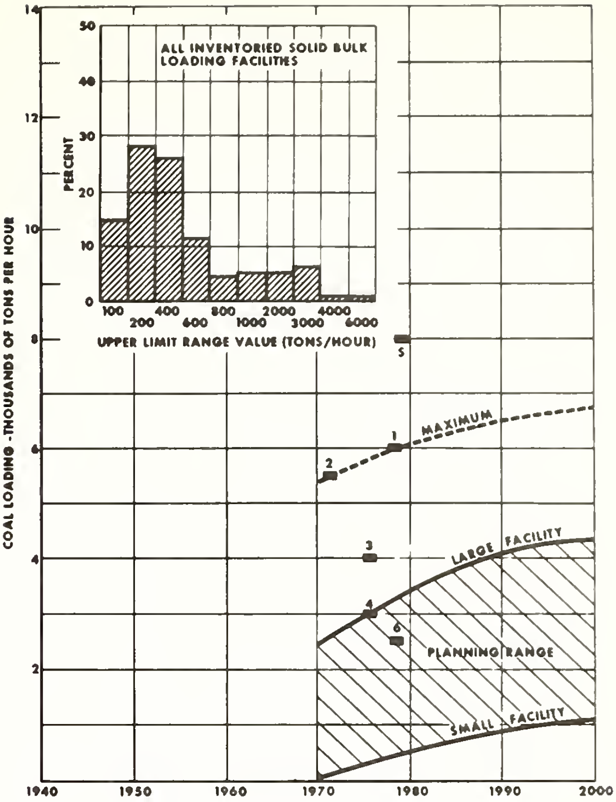
[1] Applies to Crude Petroleum and Petroleum Products, assumed at 7 bbl/st pumped at rates of 600 gpm and 1200 gpm. Design rates for Industrial Chemicals assume a greater density (with 4.17 bbl/st) but the same pumping rates, and are accordingly higher: 210 stph for small facilities and 420 stph for large facilities, both loading and unloading.

[2] Combined average for both liquid bulk and dry bulk facilities.

[3] Assuming a density of 52 pcf at which 1 bbl = 0.14 st.

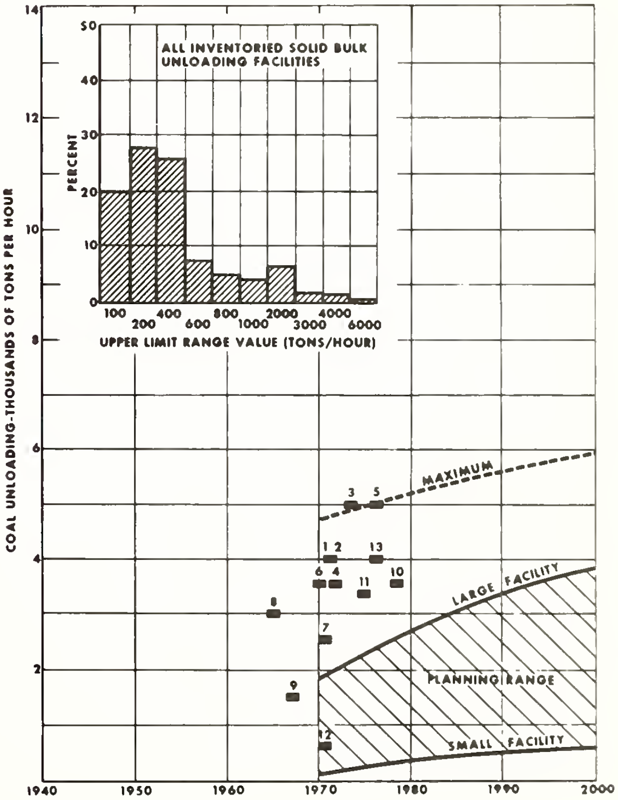
COAL LOADING

1. 6000 TPH Conveyor Belts to Unit Barge Tows (ACBL), St. Louis, Mo.
2. 5500 TPH Coal Barge Loader (ACBL) — Unionville, Ky. (See Notes)
3. 4000 TPH Barge Loader (Stationary Metropolis, ILL.
4. Service 2500, Peak 3000 TPH Coal Rail to River (Barge) Ghent, Ky. (Ohio River)
5. Thunder Bay, Ont., Travelling Shiploader, 8000 TPH, 1979
6. Licking River Rail to Barge Transfer, Near Cincinnati, 2600 TPH min, 1978



COAL UNLOADING

1. 4000 TPH Coal Bucket Elevator TVA Cumberland City, Tenn.
2. 4000 TPH Coal Bucket Elevator Scary, W.Va.
3. 5000 TPH Coal Bucket Elevator Shippingport, Pa.
4. 3600 TPH Coal Ladder Unloader Sammis Station, Stratton, Ohio
5. 5000 TPH Ladder Unloader from barges Pride, Ala.
6. 3600 TPH Coal Ladder Unloader Stuart Station, Cincinatti
7. Twin Bucket 2600 TPH Sta. Tower Memphis, Tenn (Circa 1970)
8. 3000 TPH Ladder Perez Transfer Terminal
9. Traveling Clamshell Barge Unloader — 1500 TPH Coal Crystal River Station
10. Ohio River DPL/CG&E
11. 3300 TPH Conveyor Shippingport, Pa.
12. Coal Bucket 670 TPH Sta. Hennepin, Ill. (Circa 1970)
13. Ocean Barge Tampa, Fla.



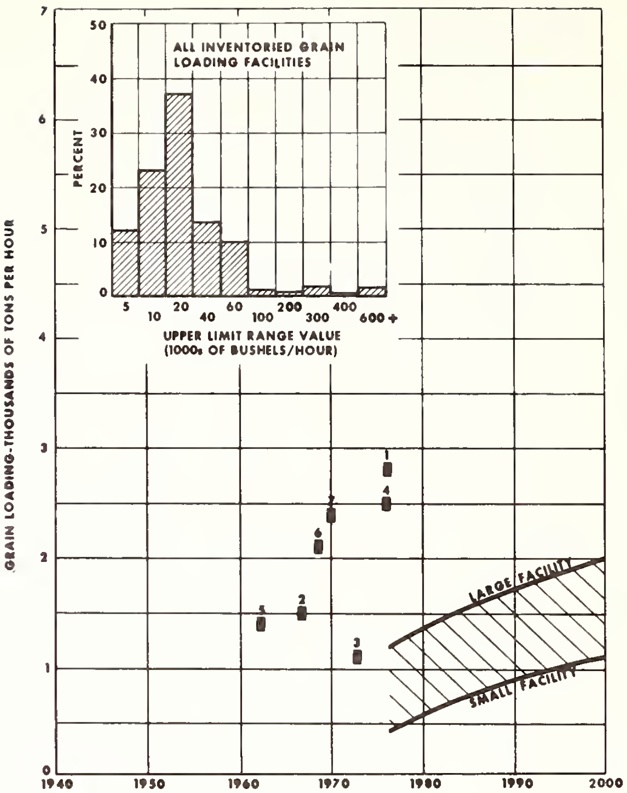
TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 19 PROJECTION OF COAL HANDLING RATES

GRAIN LOADING

1. Cook Elevator, Portland, Or., 2 Belts, 3 Spouts, 2800 THP*, 1,500,000 bu. Storage, 1976.
2. North Pacific, Kalama, Wa., 2 Belts, 7 Spouts, 1500 TPH*, 4,000,000 bu. Storage, 1966**.
3. United Grain, Vancouver, Wa., 2 Belts, 7 Spouts, 1100 TPH, Total Storage 5,000,000 bu., 1973.
4. Terminal 4 Elevator, Portland, Or., 1 Belt, 2 Spouts, 2500 THP*, 8,100,000 bu. Storage, 1976**.
5. Louis Drefus Elevator, Portland, Or., 2 Belts, 6 Spouts, 1400 TPH*, 2,000,000 bu. Storage, 1962**.
6. Bayside Elevator Co., Reserve, La., 2100 TPH* 4,000,000 bu. Storage, 1968.
7. Bunge Corp., Destrehan, La., 2400 TPH*, 8,000,000 bu. Storage, 1970.

* Loading into large vessels.
** Modified.



GRAIN UNLOADING

1. Mississippi Dock, Terra Haute, La., Bucket Wheel Elevator, 2500-3000 TPH, 1977
2. Cook Elevator, Portland, Or., Barge Unlaod, 100 TPH Marine Leg 1,500,000 bu. storage, 1976
3. North Pacific Elevator, Kalama, Wa., Marine Leg, 750 TPH, 4,000,000 bu. storage, 1966
4. United Grain Corp. Elevator, Vancouver, Wa. Marine Leg/Vacuum Leg 900/1500 TPH, 5,000,000 bu. Storage, 1975.
5. Terminal 4 Elevator, Portland, Or., Marine Leg 100 TPH, 8,100,000 bu. Storage, 1976
6. Louis Drefus Elevator, Portland, Or., Marine Leg, 600 TPH, 2,000,000 bu. storage, 1962.

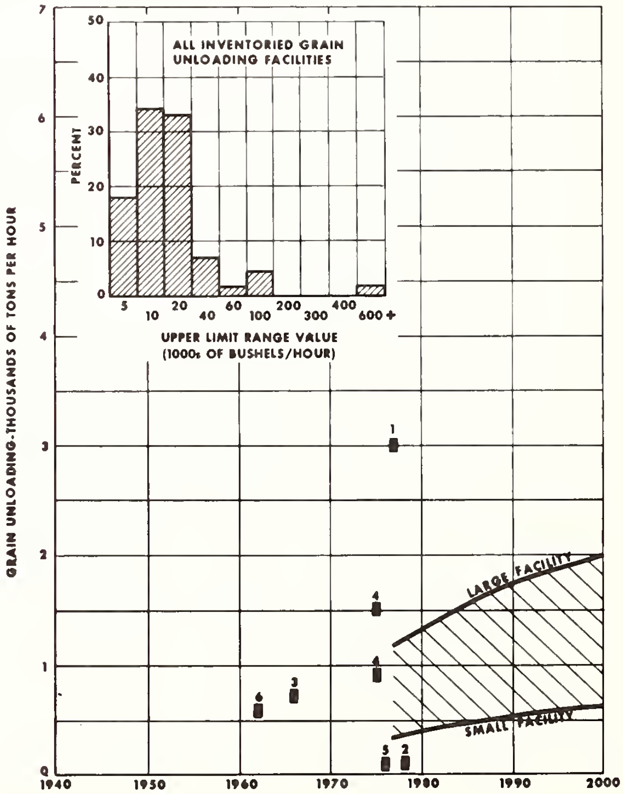


FIGURE 20 PROJECTION OF GRAIN HANDLING RATES

terminals with fewer but larger and better equipped ones. Container facilities in Mid-America will locate predominantly in deepwater ports such as New Orleans and Mobile. In general, container movement by barge will play a minor role in traffic on the inland waterways.

Few major changes are anticipated in non-containerized general cargo handling. Disposable slings and specialized equipment for handling pallets and steel plates are currently in use and may become more widespread. Most non-containerized general cargo commodities will continue to be handled by dockside cranes. In summary, current handling rates are used for the "design" break-bulk rates, as shown in Table 12-1.

CHAPTER 13

ECONOMETRIC FORECASTS

The forecast of inland waterway traffic is based upon the establishment of mathematical relationships between historical domestic waterborne commerce and independent econometric indicators for the 8-year time period 1969-1976. This chapter describes the development of and assumptions underlying the forecast of econometric indicators, which are used in the preparation of commodity forecasts described in Chapter 14.

Three econometric models generated the state-level econometric forecasts of manufacturing activity, housing starts, coal production and consumption, cash grains production and fertilizer consumption: (1) the CEAI Regional Forecasting Network (RFN); (2) a regional coal model developed specifically for the study region; and (3) a regional cash grains model, developed for the study region. Each of these models requires both U.S. level forecasts (such as crop prices, energy costs, government policy actions) and international forecasts (such as world demand and production of food grains, price of OPEC oil, world population growth). These forecasts were supplied, in turn, by other models in the CEAI network of econometric models, as shown in Figure 21. Two models were particularly important for this study -- the U.S. Agricultural Model, and the U.S. Macroeconomic Model.* The Agricultural Model provided all of the exogenous crop price and government policy forecasts required by the cash grains model; the U.S. Macroeconomic Model is the primary source of forecast inputs required by the RFN.

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* Appendix D describes the econometric equations used in the agricultural and coal forecasts.

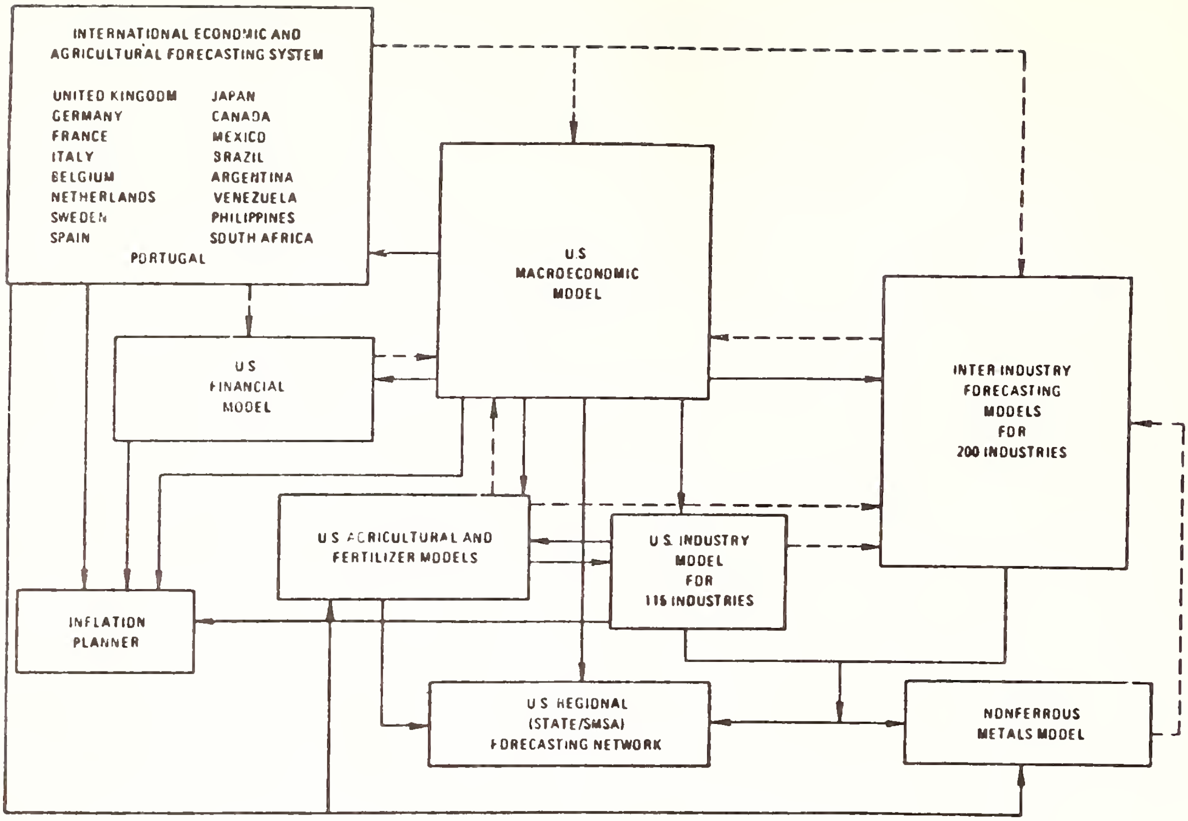
INTERNATIONAL ECONOMIC AND AGRICULTURAL FORECASTING SYSTEM
UNITED KINGDOM
GERMANY
FRANCE
ITALY
BELGIUM
NETHERLANDS
SWEDEN
SPAIN
JAPAN
CANADA
MEXICO
BRAZIL
ARGENTINA
VENEZUELA
PHILIPPINES
SOUTH AFRICA
PORTUGAL
U.S MACROECONOMIC MODEL
U.S FINANCIAL MODEL
INTER INDUSTRY FORECASTING MODELS FOR 200 INDUSTRIES
U.S AGRICULTURAL AND FERTILIZER MODELS
U.S. INDUSTRY MODEL FOR 115 INDUSTRIES
INFLATION PLANNER
U.S REGIONAL (STATE/SMSA) FORECASTING NETWORK
NONFERROUS METALS MODEL

FIGURE 21 - THE CEAI MODELING NETWORK

SCENARIOS

In The U.S. Economy to 1990: Can Stagflation Be Conquered?, a two-volume CEAI study published November 1977, CEAI outlines four different long-term outlooks, or "scenarios" for the nation's economic life; these are:

1. A baseline forecast (the "CEAI Standard Outlook"). This scenario calls for a slowdown followed by strong growth in 1980 and 1981, and a return to a long-term 3 percent-3.5 percent growth rate (real GNP), and a long-term inflation rate of 5 percent-6 percent (CPI).

2. A high growth forecast. (This was called the "consensus forecast" at the time; the consensus has shifted during the past year to CEAI's more conservative outlook.) In this outlook, real GNP grows at 3.5 percent-4 percent long-term and inflation remains at or below 5 percent.

3. A low growth forecast. In this scenario, inflation during the early 1980's surges past 6 percent, slowing real growth to 2 percent-2.5 percent.

4. A cyclic forecast. This outlook explores the consequences of a cyclical slowdown every 4 years or so. The average inflation and real GNP growth rates are about the same as those in the low.

Selected observations on each of the scenarios are summarized in the following excerpts:

1. "The least likely case, as we (CEAI) see it, is the (high growth) forecast. This could happen only if no major military upheavals occur anywhere in the world, if the Federal government is both enlightened and intelligent enough not to follow the wrong path of fiscal or monetary policies at any time, if the business community is farsighted enough never to stockpile inventories or build (or fail to build) new plants at the wrong time, and if no shortages were to develop in any of the key raw materials. Even though, an unblemished record of 13 straight years of growth would be unprecedented and seems highly unlikely. We assign a probability of less than 0.1 to the (high growth) forecast actually occurring."

2. "The cyclical case ia also not very likely although we certainly do expect business cycles to occur at fairly regular intervals during the 1980's. The reason why we assign it a probability of less than 0.2 is because part of the cyclical pattern is due to random or exogenous shocks, which we have not included in this simulation. We do expect cycles to recur every 4 to 5 years, but the exact timing is still unknown and the magnitude is likely to be more diversified than what we have shown in this forecast."

3. "The (baseline) forecast is usually the one with the highest probability, but not this time. While we do expect a slowdown to occur next year, the rest of the period is much too smooth to qualify as having a very high probability. Many of the same comments which apply to the (high growth) forecast also apply in this case. However, while we think that some shocks are likely based on past experience, we do not know what they will be nor exactly when they will occur. Thus, we have assigned a probability of about 0.3 to this alternative."

4. "This leaves, almost by default, the (low growth) case as the most likely one, with a probability in excess of 0.4. By this we certainly do not mean that there is almost a 50-50 chance that the Arabs will actually raise their oil prices by exactly $10/bbl. in 1985, nor that inflation will, in fact, be 8.5 percent next year, followed by a recession in which real GNP declines 0.6 percent the next year. Instead, we are suggesting that the probability of shortages in basic commodities and substantial further increases in oil prices are fairly high, and if these do happen, we can expect them to be followed by a sizable negative effect on real GNP. The sluggish growth of the capital stock, coupled with severe declines in productive real fixed business investment in the basic industries, make this forecast more than just a scare story."

REGIONAL FORECASTS

With the exception of coal, fertilizers and cash grains (which account for about half the total volume of waterway traffic), forecast variables for this study's commodity groups were obtained from the CEAI Regional Forecasting Network (RFN). Two points are important to an understanding of the RFN: first, it is to a great extent "driven" by the CEAI Macroeconomic Model referred to in the preceding discussion; and, second, each state responds uniquely to a given set of macroeconomic assumptions.

Figure 22 graphically illustrates the key relationships which comprise the RFN. Most of the RFN forecast variables used in this study were derived from the manufacturing output sectors of the model, which are influenced primarily by three factors: the (national) index of industrial production for the given (two-digit) industry, the level of (national) capacity utilization, and the relative profitability of the given state or region.

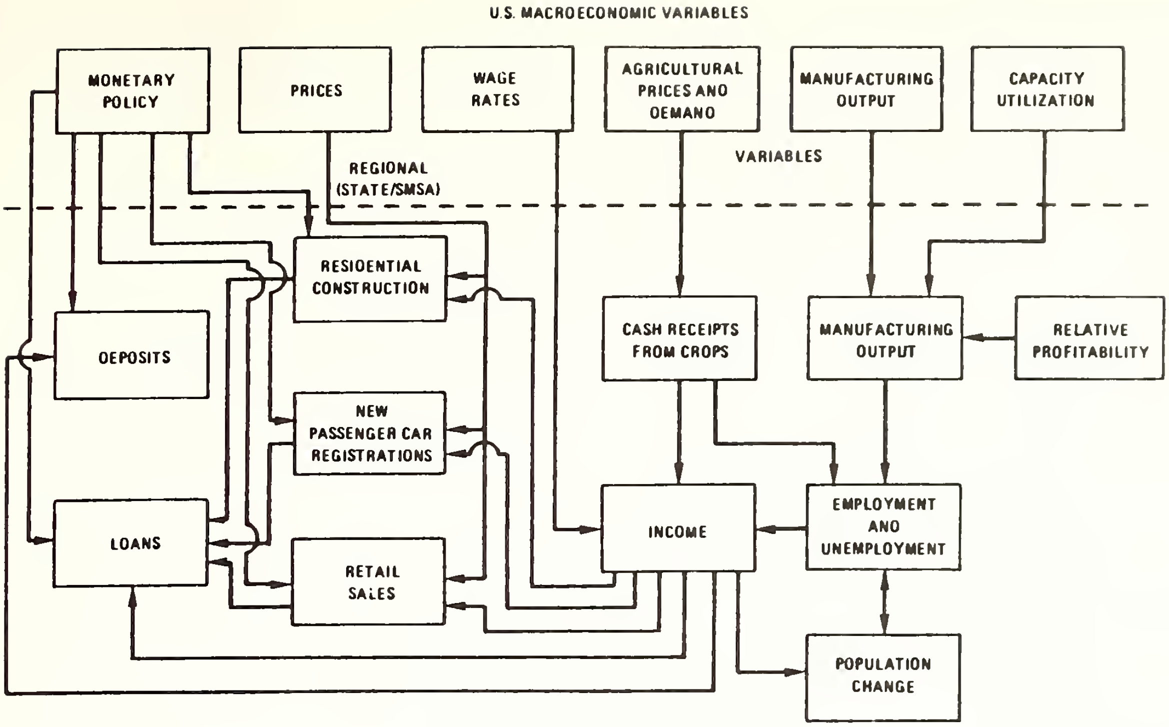
U.S. MACROECONOMIC VARIABLES
MONETARY POLICY
PRICES
WAGE RATES
AGRICULTURAL PRICES AND DEMAND
MANUFACTURING OUTPUT
CAPACITY UTILIZATION
REGIONAL (STATE/SMSA)
VARIABLES
RESIDENTIAL CONSTRUCTION
DEPOSITS
CASH RECEIPTS FROM CROPS
MANUFACTURING OUTPUT
RELATIVE PROFITABILITY
NEW PASSENGER CAR REGISTRATIONS
LOANS
RETAIL SALES
INCOME
EMPLOYMENT AND UNEMPLOYMENT
POPULATION CHANGE

FIGURE 22 - THE CHASE REGIONAL FORECASTING NETWORK

The importance of the concept of relative profitability to developing forecasts for this study was discussed in "Economics and Demographics" (Chapter 3). The concept is incorporated through a CEAI developed index which combines the four key relative costs -- tax load, labor cost, electricity cost, and the cost of industrial natural gas. A similar concept applies across industries as well as across states. The relative profitability term for industries is an important determinant of growth, second only to demand variables, and accounts for a good portion of the variations in the history and forecast displayed in Table 13-1.

TABLE 13-1

GROWTH RATES FOR SELECTED INDUSTRIES: NATIONAL
(Average annual growth in %)

	History 1969-1976	CEAI Forecast 1976-1986
SIC 20 Foods	2.7	2.8
SIC 24 Lumber and products	1.5	4.8
SIC 26 Paper and products	1.6	4.2
SIC 28 Chemicals and products	3.6	5.5
SIC 29 Petroleum and coal products	2.5	2.0
SIC 33 Primary metals	-0.3	3.5
SIC 34 Fabricated metal products	0.9	3.9
Total Manufacturing Output	2.2	4.6
Housing Starts- Total	0.5	4.4

Data Source: Annual Survey of Manufactures
Forecast Source: Chase Econometric Associates, Inc.

Relative regional profitability interacts with national industrial output and capacity utilization measures in the RFN at the two-digit SIC-code level. The resulting aggregate manufacturing output for each state is compared in Table 13-2.

One important forecast series which does not issue from the manufacturing output sector of the Regional Forecasting Network is housing starts. Although technically an investment function, housing starts are modeled by state very much like a consumption function for a durable. The key demand pressure is disposable income within the state, which interacts with local credit conditions, population, housing stocks and the relative price of new homes to generate the forecast for local housing

TABLE 13-2

GROWTH RATES FOR MANUFACTURING OUTPUT IN SELECTED STATES

(Average annual growth in %)

	History 1969-1976	CEAI Forecast 1976-1986
Alabama	2.51	4.80
Arkansas	5.19	6.60
Illinois	0.79	4.22
Indiana	0.39	3.95
Iowa	3.72	4.86
Kansas	4.48	3.87
Kentucky	3.70	4.82
Louisiana	7.21	4.21
Michigan	-0.40	1.46
Minnesota	0.98	4.41
Mississippi	5.94	5.68
Missouri	-0.22	3.94
Nebraska	3.58	6.19
North Dakota	7.24	6.19
Ohio	-0.27	3.42
Oklahoma	6.20	5.88
Pennsylvania	-0.75	3.91
South Dakota	4.64	4.63
Tennessee	2.09	4.81
Texas	4.03	6.84
Virginia	2.72	5.23
West Virginia	-0.60	2.94
Wisconsin	2.24	3.79
U.S.	2.22	4.60

Source: Chase Econometric Associates, Inc.

Forecast Source: Chase Econometrics Associates, Inc.

starts. Wherever local coverage of housing starts is substantially less than average coverage, the CEAI series represents its estimate of total housing activity within a state, based on that state's available data and demographics.

COAL FORECASTS

Approximately one-third of the tonnage which moves through the Mid-America waterways system is coal. For that reason, the issues and assumptions which directly effect the production and consumption of coal have a major impact on this study. Of particular relevance are assumptions about the direction of U.S. energy policies, the rate of development of western coal mines, and the relative cost of all energy sources to each other and to the economy as a whole.

Summarized below is CEAI's estimate of what the final, long-term legislation will involve, regardless of when that legislation is actually passed. The critical assumptions and a brief explanation of each are as follows:

Coal Conversion

- All new "large" industrial and power plants will have to use coal (exemptions only on a case-by-case basis).
- Existing power plants will be required to convert to coal by 1990 (exemptions only on a case-by-case basis).
- Existing industrial plants will be required to convert to coal (only on a case-by-case basis).

Utility Rate Reform

- The Department of Energy will be limited to advocating conservation and other rate setting positions before state utility regulatory commissions. No minimum national standards, appeals to the courts or veto powers will be authorized.
- The elderly will receive lower rates.

Energy Taxes

- No large gasoline taxes and only very limited taxes on industrial use of oil and gas will be included.
- Tax credits will be given to homeowners and businesses for use of energy saving devices; a tax credit for oil from shale will be voted along with tax credits for other unconventional sources.
- Tax credits for converting existing boilers from oil or gas to coal will also be granted.
- $.04/gallon motor fuels tax will be extended and a "gas guzzler" tax passed.
- Some combination of taxes and partial (phased) deregulation will be incorporated to bring domestic crude to world levels by the early 1980's with decontrol thereafter on newly discovered oil.

Natural Gas Prices

- Ceiling prices for newly discovered gas will rise toward decontrol proportionate with the total price of domestic crude, including any well head taxes. Thus, "new" gas would be decontrolled in the early 1980's.
- Intra-state gas will not be controlled.
- Incremental pricing will be incorporated (small users will get first priority on old cheap gas).

Conservation

- Appliance efficiency standards will be included.
- "Gas guzzlers" will be taxed heavily in the 1980's.
- Federal energy conservation will be encouraged.
- Utilities will be required to help howmeowners.
- Insulate existing homes.

With respect to the development of western coal, present legislative bills give rise to several distinct long-term scenarios. The scenario underlying the price/cost forecasts, production and consumption forecasts for this study is one of the more optimistic ones. It assumes that western coal will be strip mined; it also assumes that the transport network to move this coal East -- primarily rail -- can be created by upgrading existing roadbeds, and that total car capacity can be expanded over a period of three or four years.

With regard to the long-run labor outlook, one can assume that the United Mine Workers Union will retain its hold on coal mining; that is, management confrontation will continue indefinitely; and that the union will effectively obtain increases in wages and other compensation of about 12 percent to 14 percent per year. As the proportion of coal drawn from large stripping operations increases, the average productivity of coal mining will increase. There will be, therefore, significant offsets to increasing labor costs at the aggregate level. The cost of mining equipment, particularly the very large pieces of machinery that are used for strip mining, are likely to show price increases of nearly 10 percent per year for the next five to six years. On the other hand, the capital intensity of strip mining is somewhat lower than that of deep mining. The result of combining all these factors is an increase of about 5 percent in the price index for bituminous coal for the balance of this decade, and increases on the order of 7 percent to 8 percent in the next decade. The rate of increase in lignite prices will be significantly lower, due to its perception as an inferior product. Prices for metallurgical coal are presently significantly higher than those for steam coal, and they will remain so.

Tables 13-3 and 13-4 summarize the simulations based on the foregoing assumptions. It is important to note that the rate of growth for coal production in the study region lags the overall growth rate throughout the 1980's (4.2 percent vs. the U.S. rate of 7.9 percent) due to the development of western coal. In the 1990's, however, the study region's anticipated growth in production is on a par with the country as a whole.

TABLE 13-3

U.S. ENERGY CONSUMPTION
(Quadrillions of BTU's)

	Natural Gas	Coal	Petroleum	Other	Total
1972	23.0	12.4	33.0	3.5	71.9
1973	22.5	12.3	34.9	3.9	74.6
1974	21.7	12.9	33.5	4.5	72.6
1975	19.9	12.8	32.7	5.1	70.6
1980	20.3	16.0	40.2	7.0	83.5
1985	20.9	21.1	42.4	11.2	95.6
1990	20.4	31.5	40.1	16.5	108.1
2000	19.3	49.9	35.7	29.5	134.4

Data Source: Department of Energy
Forecast Source: Chase Econometric Associates, Inc.

TABLE 13-4

U.S. COAL

(Millions of short tons)

	Consumption	Production	
		U.S.	Study Region
1972	522.7	602.5	544.4
1973	561.7	598.5	528.3
1974	558.2	610.0	524.3
1975	561.4	654.6	552.3
1980	700.0	783.1	613.6
1985	925.0	1034.8	749.5
1990	1380.0	1543.8	927.3
2000	2186.0	2445.5	1526.3

Data Source: Department of Energy
Forecast Source: Chase Econometric Associates, Inc.

State Coal Forecasts

Table 13-5 summarizes historical and forecast coal production through the year 2000 by state. Similarly, Table 13-6 summarizes historical and forecast coal consumption by state. Study area production of coal is forecast to increase from a 1975 level of 544 million short tons to a year 2000 level of 1,526 million short tons, or an increase of 180 percent. Forecasts were provided for all states for which data are available (i.e., reported by the Department of Energy). In the case of coal for Arkansas, Louisiana and Oklahoma, consumption data are available only for several years. These data are inadequate to estimate econometric equations, and consumption levels in these states are so minor that local consumption could not be used to explain waterborne traffic flows through these states.

Several states have prepared their own forecasts of production and generally view the forecasts used for this study as too low. Kentucky researchers, for example, forecast a 1976-1981 growth rate of 6.1%. Other forecasts, however, by the U.S. Department of Commerce and Oak Ridge National Laboratory had projected long-term growth rates in the 1%-2% range for the state. At the time CEAI prepared its forecast (over 18 months prior to the publication date of this report), only 1976 preliminary data were available. Current data indicate that in 1977 Kentucky coal production fell 0.7% from 1976. January-September 1978 production in Kentucky is running almost 18 percent below the same period in 1977. Production during the first quarter of 1978 was reduced by the coal strike. However, second and third quarter production was 5.5% and 20% below year-earlier levels in the state. Thus, CEAI believes its relatively modest growth rate forecast of 0.7% (1976-1985) remains sound in light of recent developments.

In similar fashion, Ohio Department of Transportation forecasts coal consumption for their state through the year 2000

TABLE 13-5

HISTORICAL AND FORECAST COAL PRODUCTION, BY STATE

(000 short tons)

	History		CEAI Forecast			
Year	1969	1976	1980	1985	1990	2000
Alabama	17,456	21,605	26,963	38,671	54,615	110,626
Arkansas*	NA	NA	NA	NA	NA	NA
Illinois	64,722	57,974	62,739	65,870	68,329	74,418
Iowa *	NA	-	-	-	-	-
Kansas*	NA	-	-	-	-	-
Kentucky	109,050	140,000	143,558	149,096	158,724	175,350
Louisiana *	NA	-	-	-	-	-
Minnesota *	NA	-	-	-	-	-
Mississippi*	NA	-	-	-	-	-
Missouri	3,301	5,415	6,448	8,765	11,767	21,471
Nebraska*	NA	-	-	-	-	-
Ohio	51,242	45,484	51,366	55,686	59,789	69,593
Oklahoma	1,838	3,299	3,140	4,274	5,733	10,466
Pennsylvania	78,631	83,654	91,131	110,780	134,137	197,438
Tennessee	8,082	8,755	9,645	10,979	12,420	15,993
West Virginia	141,011	108,863	106,351	103,044	99,833	93,713
Wisconsin *	NA	-	-	-	-	-
Indiana	20,086	24,136	31,278	42,880	58,076	107,834

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*See section entitled, "State Coal Forecasts"

Data Source: Department of Energy

Forecast Source: Chase Econometric Associates, Inc.

TABLE 13-6

HISTORICAL AND FORECAST COAL CONSUMPTION, BY STATE

(000 short tons)

	History		CEAI Forecast			
Year	1969	1976	1980	1985	1990	2000
Alabama/Mississippi	25,582	39,455	53,287	59,881	66,436	82,830
Arkansas*	NA	NA	NA	NA	NA	NA
Illinois	45,244	54,288	70,047	73,603	76,491	83,528
Iowa	5,673	6,865	7,399	8,242	9,150	11,315
Kansas/Nebraska	1,470	4,207	4,906	6,058	7,399	11,160
Kentucky	20,355	36,797	57,144	69,584	82,547	119,244
Louisiana*	NA	NA	NA	NA	NA	NA
Minnesota	8,100	12,076	15,637	17,997	20,475	26,810
Mississippi/Alabama	25,582	39,455	53,287	59,881	66,436	82,830
Missouri	11,098	17,074	19,274	22,574	26,326	35,958
Nebraska/Kansas	1,470	4,207	4,906	6,058	7,399	11,160
Ohio	62,160	68,394	74,938	86,419	99,007	130,808
Oklahoma*	NA	NA	NA	NA	NA	NA
Pennsylvania	59,661	68,293	76,208	83,186	90,443	107,336
Tennessee	16,793	29,948	42,171	48,349	54,574	70,624
West Virginia	24,356	37,324	45,589	57,686	72,065	113,918
Wisconsin	14,972	20,008	26,887	27,982	28,765	30,775
Indiana	41,299	51,202	61,156	67,099	73,105	87,390

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*See section entitled, "State Coal Forecasts"

Data Source: Department of Energy

Forecast Source: Chase Econometric Associates, Inc.

grow at an average annual rate of 2.5 percent, in comparison to the 2 percent rate forecast in this study. Ohio coal has a high sulfur content and the state forecast assumes that a compromise will be reached between Federal and state agencies which will permit consumption of the Ohio coal by utilities at a rate equal to or higher than in the past. This assumption regarding use of high sulfur content coal accounts for the difference between the two forecasts.

CASH GRAINS FORECAST

The cash grains analysis takes two forms. The first is a "forecast scenario" detailing the key elements of the forecast for the immediate future (1979-1980), for the mid-term (to 1985), and for the long-term (to 2000). The second is a short discussion of the key issues affecting any long-term forecast of these commodities.

Near-Term Outlook (1979-1980)

Overproduction in the agricultural sector, combined with a weak 1979 performance by the U.S. economy, make for a rather bleak short-term outlook. Huge domestic and world grain stocks have forced a return to acreage set-asides for the next 3-4 years. Between 10 and 20 million acres will be diverted from production during this period.

Export tonnage of wheat, corn, soybeans and soybean meal will increase from 1977's total of 87.7 million metric tons (crop year basis) to 109.9 million in 1980, an annual growth rate of under 8 percent, compared to the average annual growth rate in excess of 16 percent that characterized the first half of this decade. The slowing in U.S. exports is due to an expansion in world grain production to pre-1972 levels, decreased world livestock numbers, and an anticipated poor performance of the world economy during 1979. Sluggish demand and high world grain stocks mean many countries will rely less on U.S. grain to meet their needs for the next two to three years.

Domestic consumption of cash grains will increase at an annual 5 percent rate, due in large part to the anticipated recovery of the livestock industry. The low grain prices mean a return to profitability for the livestock producers, who will seek to step up production and, by doing so, will demand more corn and soybean meal for feed.

Mid-Term Outlook (1985)

Inexpensive feed grains are expected to stimulate the USSR, Eastern Europe, China and other developing countries to once again expand their livestock production throughout the 1980's, creating a demand for grains over and above their production capacities. The combination of increasing population and rising income throughout the developing nations will also lead to a demand for grains in excess of indigenous production capacity. As more populations make the shift from cereal to animal proteins, grain demand typically makes a quantitative leap, since meat production is typically "grain intensive" (when compared to direct human grain consumption). Thus, the 1980's will again see a return to strong U.S. grain exports.

Long-Term Outlook (to 2000)

By the end of this century, world population will total 6.5 billion, an increase of over 50 percent from the current level (see Table 13-7). This implies that the need for food will continue to exceed the ability of many countries to produce food grains. We also anticipate that the trend towards higher per capita incomes in the developing nations will continue throughout the forecast horizon (see Figure 23). This means that the demand for food will rise more rapidly than production, placing the U.S. in an increasingly favorable position as food exporter (see Table 13-8). The increasing demand for agricultural commodities will also tend to bid up relative prices; the consequent increase in farm profitability will continue to pull marginal lands into production (see Table 13-9).

TABLE 13-7

WORLD POPULATION PROJECTIONS
(Millions)

Population	1950	1960	1970	1975	1985	2000	Average Annual Growth Rate 1979-2000
World	2,501	2,986	3,610	3,967	4,816	6,253	1.9%
Developed Countries	857	976	1,084	1,132	1,231	1,361	0.8%
Developing Countries	1,644	2,010	2,526	2,835	3,585	4,893	2.3%
People's Republic of China (PRC)	558	654	772	839	973	1,148	1.3%
Excluding PRC	1,086	1,356	1,754	1,996	2,612	3,745	2.6%

Note: Above assumes declining fertility - U.N. medium projection.

TABLE 13-8

U.S. PRODUCTION AND EXPORTS OF CASH GRAINS

(Millions of bushels, crop years)

	Historical						Forecast		
	1965	1970	1975	1976	1977	1978	1980	1985	2000
WHEAT									
Production	1313.3	1350.5	2122.5	2142.4	2025.4	1775.2	2059.3	2744.8	3914.0
Exports	726.5	711.5	1177.1	1020.4	937.5	1290.1	1280.0	1727.0	2195.0
Exports %	55.3	52.7	55.4	47.6	46.3	72.7	62.2	62.9	57.7
CORN									
Production	3956.3	4152.7	5829.0	6266.4	6370.6	6890.1	6535.7	8336.8	10928.0
Exports	615.0	582.0	1330.4	1755.7	1604.4	2014.7	1910.0	1727.0	2919.0
Exports %	15.5	14.0	22.8	28.0	25.2	29.2	29.2	20.7	27.5
SOYBEANS									
Production	844.0	1128.0	1547.4	1287.6	1761.8	1810.4	1884.4	2109.5	2468.0
Exports*	320.8	612.0	634.9	792.0	787.4	989.0	975.8	1178.6	1438.0
Exports %	.380	54.3	41.0	61.9	44.7	54.6	51.8	55.9	60.0

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* Includes meal in soybean equivalent bushels.

Data Source:U.S. Department of Agriculture

Forecast Source: Chase Econometric Associates, Inc.

TABLE 13-9

FORECAST GRAIN PRODUCTION
(Millions short tons)

Year	1977	1980	1985	1990	1995	2000
Alabama	1.59	2.00	1.87	1.95	2.09	2.26
Arkansas	3.88	3.24	3.79	4.02	4.22	4.45
Illinois	44.43	45.73	51.00	55.34	59.32	63.32
Indiana	22.83	21.80	26.07	29.73	32.18	34.56
Iowa	42.28	41.53	47.64	53.41	57.60	61.29
Kansas	16.81	16.80	19.18	21.23	23.32	25.57
Kentucky	4.92	4.63	4.67	5.21	5.62	6.04
Louisiana	2.07	2.25	2.41	2.61	2.85	3.10
Minnesota	18.90	19.53	22.53	24.83	26.55	28.17
Mississippi	3.03	2.59	2.67	2.88	3.00	3.10
Missouri	10.88	11.08	11.97	12.93	13.92	14.88
Nebraska	20.40	20.39	23.15	25.58	27.65	29.65
North Dakota	7.65	8.88	11.19	12.67	14.16	15.69
Ohio	15.32	15.47	16.76	18.79	20.28	21.67
Oklahoma	5.10	5.35	5.79	6.07	6.26	6.46
Pennsylvania	3.20	2.81	2.94	3.35	3.64	3.93
South Dakota	4.37	5.49	5.97	6.23	6.48	6.60
Tennessee	3.30	3.06	3.30	3.56	3.77	3.98
West Virginia	0.14	0.14	0.14	0.14	0.15	0.15
Wisconsin	5.96	5.04	5.40	6.33	6.88	7.41
Total	237.07	237.83	268.45	296.84	319.92	342.29

Data Source: U.S. Department of Agriculture

Forecast Source: Chase Econometric Associates, Inc.

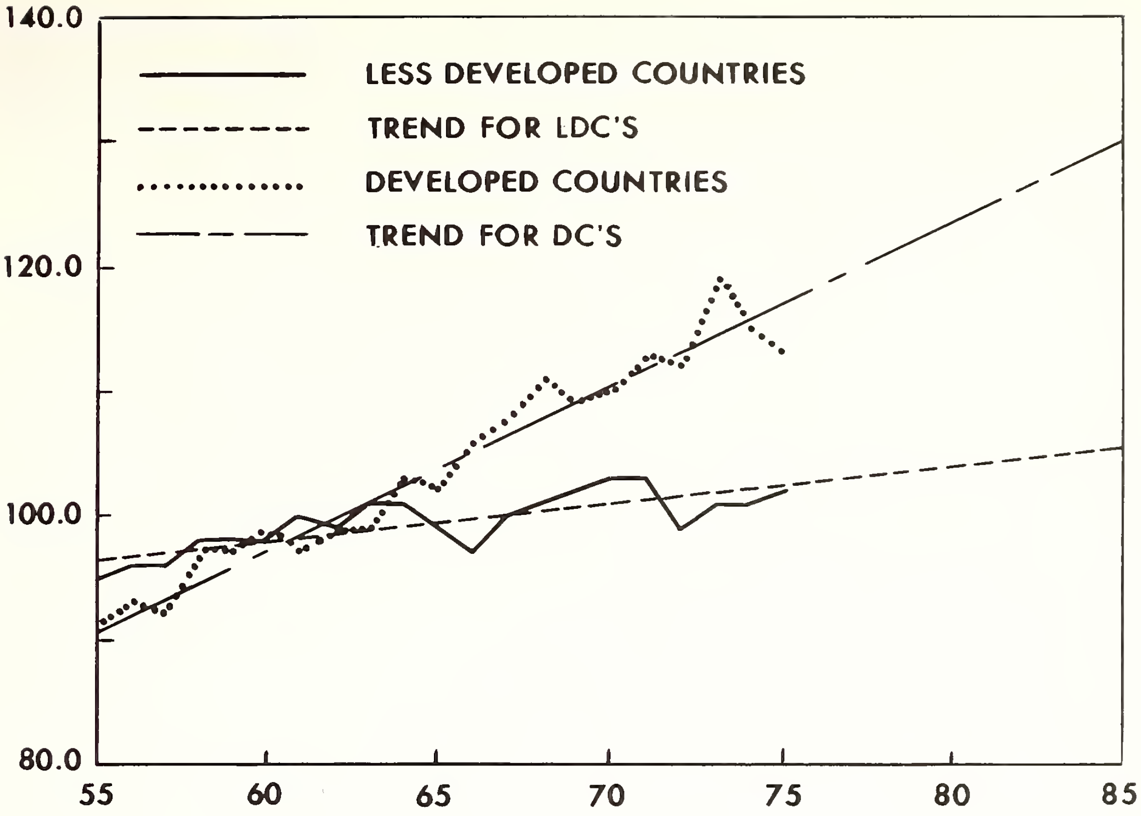


FIGURE 23 - AGRICULTURAL PRODUCTION IN PER CAPITA INDICES
PERCENT OF 1961 to 1985 AVERAGE

A summary of the agricultural forecast issues is presented below.

Energy Cost and Availability

- Two key policy assumptions are made for this forecast. First, it is assumed the net effect of U.S. energy policies over the next several decades will be to permit a continuing, moderate increase in the relative cost of petroleum and natural gas, in order to encourage either more efficient utilization or change-overs to other energy sources, where possible. Second, it is assumed that agriculture's energy needs will continue to receive priority consideration by policy makers. A third key assumption is simply that supplies of petroleum and natural gas will, in fact, be adequate throughout the forecast period.

Although petroleum and natural gas are important for a variety of reasons, several are exceptionally noteworthy for agriculture. The extremely high productivity of the American farmer is due in large part to his generous application of commercial fertilizers. The price and availability of fertilizers are in large measure dependent on the price and availability of natural gas, which is an important feedstock for commercial production. A second important element in U.S. nitrogen fertilizer farm productivity is the wide use of herbicides and pesticides to enhance yield and quality. Again, the manufacture of most herbicides and pesticides requires petroleum as a feedstock. A third factor in our current farm productivity has been the use of increasingly more powerful farm machinery, almost all of which is driven by gas or diesel engines. By permitting more timely planting, cultivation and harvesting operations, these machines have increased yields.

Current agricultural technology is thus heavily dependent on fossil fuels. No rapid, large shift away from this dependence is currently possible, nor is it likely during the forecast period. Therefore, any change in the assumptions outlined above would materially affect our forecast.

Foreign Demand for U.S. Agricultural Production

- Several policy assumptions affect our outlook for export activity. First, we have assumed that the USSR, the Eastern Bloc countries and the People's Repbulic of China will continue to supplement crop short-falls with purchases of U.S. grains, rather than reducing efforts to upgrade their diet with livestock products. Second, we have assumed the U.S. government will maintain a very favorable stance toward nations which are large importers of U.S. agricultural commodities. The U.S., reacting to the 1973's short soybean supplies and high prices, restricted soybean sales to Japan, one of our largest customers; Japan, in an effort to assure a reliable source of supply, began to invest heavily in Brazilian soybean production. We believe that a repetition of that type of policy action is less likely than at any time in the past. Finally, we have assumed that the developed nations will continue to provide a variety of direct and indirect food aids to the underdeveloped countries.

We have adopted the assumptions which comprise the current U.N. "medium" population projections (see Table 13-7). We have also assumed that the current trends in per capita agricultural production will continue for the foreseeable future (see Figure 23). Basically, this means that the developing nations will continue to find it difficult to produce enough food to feed their populations.

Management of the Farm Operation

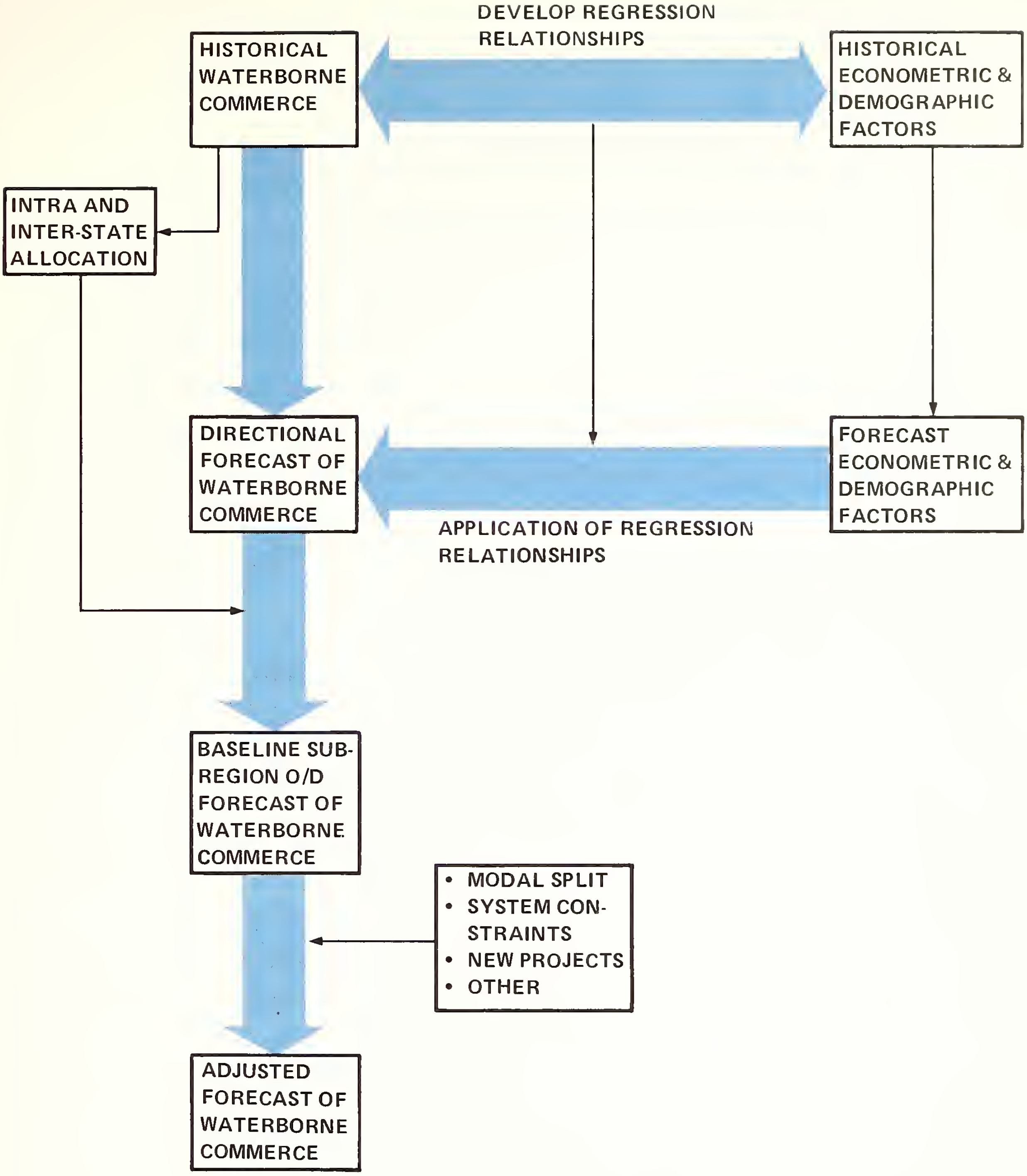
- The past decades have witnessed a decline in the number of farms and a continuing increase in the size of the average farm. We have assumed these trends will continue over the next several decades. We have also assumed that this continuing attrition will affect the poorer farm managers, effectively increasing the overall management performance of the farm sector. Today, for example, the top farmers get corn yields of 150 bushels per acre, compared to 1972's U.S. average of 97 bushels per acre; top soybean farmers get 45 bushels per acre, compared to an average of 28-30 bushels; top winter wheat producers get 50 bushels per acre, compared to an average of 34.

  Simply a broader application of the top farm manager's skills would increase the productivity of the farm sector, without any change in technology. Thus, the assumption of continually increasing levels of competence on the part of farm managers over the next several decades is a key assumption.

Agricultural Technology

- A continuing advance in the level of technology available to and used by the farm sector is assumed. It is also assumed that no major technological breakthrough of significant magnitude as to alter the basic structure of the farm sector. For example, the advent of textured protein products suddenly replacing the livestock industry in the next several decades is not envisioned; a more likely occurrence is increasing use of textured proteins during times when high beef prices prevail, coupled with a slowly increasing long-term market share. It is envisioned that there will be more exploration of alternate technologies, such as the use of biological controls for insects rather than pesticides, weed-resisting crop varieties to cut usage of herbicides, and "time-release fertilizers" to reduce fertilizer use while maintaining yields.

Present experimentation with plant varieties will continue, also. Use of currently available hybrid wheats will increase, as development continues. We expect the experimentation on hylisine corn varieties to continue, but do not foresee major shifts in current feed sources or economics as a result. Work on high yield soybeans will also continue, but we do not foresee any major breakthroughs during the forecast horizon. All of these are within our current reach, yet none entails a major structural shift in U.S. agriculture.


DEVELOP REGRESSION RELATIONSHIPS
HISTORICAL WATERBORNE COMMERCE
HISTORICAL ECONOMETRIC & DEMOGRAPHIC FACTORS
INTRA AND INTER-STATE ALLOCATION
DIRECTIONAL FORECAST OF WATERBORNE COMMERCE
FORECAST ECONOMETRIC & DEMOGRAPHIC FACTORS
APPLICATION OF REGRESSION RELATIONSHIPS
BASELINE SUB-REGION O/D FORECAST OF WATERBORNE COMMERCE
• MODAL SPLIT
• SYSTEM CONSTRAINTS
• NEW PROJECTS
• OTHER
ADJUSTED FORECAST OF WATERBORNE COMMERCE

TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 24 COMMODITY FORECAST METHODOLOGY

CHAPTER 14

WATERBORNE COMMODITY FORECASTS

This chapter describes the development of the waterborne commodity forecasts to the year 2000 and presents summary forecast findings. These forecasts are used to evaluate port terminal needs and project future requirements.

METHODOLOGY

The forecast of inland waterborne commerce was accomplished by establishing relationships between historical domestic waterborne statistics and independent historical econometric indicators for the eight-year time period 1969-1976. These relationships were then used to project baseline waterborne commerce to the year 2000 on the basis of forecasted econometric indicators for the same time period.* The baseline forecast was adjusted to reflect the influence of waterway user charge, lock and dam capacity constraints, western coal movements and the completion of new waterways. Figure 24 shows the basic components of the traffic forecast process, given the availability of a regressible eight-year flow history for a state commodity direction.

A number of steps were required to establish historical relationships between econometric and demographic indicators and domestic waterborne commerce. For the waterborne commerce side of the equations, 20 commodity groups and 89 subregions were developed by aggregating more than 150 commodities and 3,500 Army Corps of Engineer channels in the 17 Mid-America states. An array of historical and forecast econometric and demographic independent vairables was generated for each of the Mid-America states.

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* The forecast of econometric factors is described in the previous chapter.

Methodology Selection

There were several major considerations which influenced the development of the selected forecast methodology. The small number of actual commodity flows observed relative to the potential and the availability of econometric data proved to be the two deciding factors. Econometric and demographic data are not available at the subregion level; this precluded using the subregion as the basis for the primary forecast.

The low density of state pair flow data supported a methodology based on primary forecasting of state inbound or outbound and intra-state movement. The forecast of state pair movements was developed from the allocation of inbound movements to their source state and outbound movements to their destination states based on historical state pair flow patterns.

This methodology entailed use of a three-step procedure, namely:

1. The forecasting of intra and inbound or outbound movements for each region;
2. The development of state-to-state movements and the destination of outbound movements (and sources of inbound movements) from each state by trending the historic flow patterns between the states; and,
3. The development of subregion-to-subregion movements under the umbrella of each state pair using trended distributions of the total pair flow.

These steps are applied to each state, commodity and direction of flow including intrastate movements.

Forecast State Intra, Inbound or Outbound Commodity Movements

The intrastate flows were forecast for each state; however, either the inbound or outbound direction for interstate movements had to be selected as the basis for the primary forecast. The selected direction was then used in the second step as one end point in the development of state origin and destination movements.

The selection of inbound or outbound movements was done by analyzing preliminary forecasts for both directions and selecting that direction which had the better historic relationship between commodity volumes and the econometric series.

Once the direction was selected, the forecast trend was developed using three different statistical methods, the choice of which depended on the characteristics of each eight-year (1969-1976) historical flow. These characteristics considered the quality of relationship between the econometric series and the historical flows and the density of flow data where regressions were not applicable.

Where a relationship between the commodity movement and the associated econometric series could not be established which explained more than half of the variation in trade volumes or where there were less than eight years of continuous commodity movements, state econometric growth rates were applied to initialize 1976 trade values.* The initialized 1976 trade value was calculated as a weighted average of the historic non-zero movements. The growth rate was determined from the coefficient of the regressed relationship between the associated econometric variable and the log of time.

Where no movement was observed in 1975 or 1976 (except where there were six continuous movements through 1974), the initialized 1976 value was set at zero and no future movements were forecast.

The regression method was utilized to forecast approximately 65 percent of the interstate and 45 percent of the intrastate flows. The econometric series used to develop growth rates for the weighted average method are shown in Table 14-1.

Using these three methods forecasts for each state, commodity and direction (intra and inbound or outbound) were made for 1980, 1985, 1990 and 2000.

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* One of the observed movements had to occur in 1975 or 1976.

TABLE 14-1

ECONOMETRICS UTILIZED FOR GROWTH RATES APPLIED TO INITIALIZED 1976 COMMODITY MOVEMENTS

For All Non-Regressable Flows

Group	Commodity Group	Designated Interstate Direction[1] for all Forecasting	Econometric Factor[2]
01	Cash Grains	In	Grain Production
02	Metallic Ores	Out	Primary Metal Productions
03	Non-Metallic Ores	In	Primary Metal Production
04	Coal	Out	Coal Production (coal consumption intrastate)
05	Crude Petroleum	Out	Petroleum Production
06	Petroleum Products	In	Petroleum Production
07	Industrial Chemicals	In	Chemical Production
08	Ag. Chemical/Fertilizers	Out	Chemical Production
09	Milled Grain	In	Food Production
10	Lumber/Wood	Out	Lumber Production
11	Sugar/Molasses	In	Food Production
12	Primary Metals	Out	Primary Metal Production
13	Fabricated Metals	Out	Metal Fabrication
14	Scrap Metal	Out	Primary Metal Production
15	Construction Material	In	State Manufacturing
16	Mining Products	Out	State Manufacturing
17	Non-Durable Manufacture	In	State Manufacturing
18	Durable Manufacture	Out	State Manufacturing
19	Waste and Scrap	Out	State Manufacturing
20	Waterway Improvement Material	In	State Manufacturing

[1] Direction determined by response of regressible flows.

[2] Growth rates were determined on the basis of the log of the econometric regressed against time. The anti-log of the slope of this relationship is equivalent to the annual growth rate multiplier.

Source: Temple, Barker & Sloane, Inc.

Development of State-to-State Commodity Movements

At the state level, an allocation process was used to generate state-to-state movements. This allocation was based on trends in the historic patterns of commodity movements between state pairs. Depending upon whether the outbound movements of a commodity were designated for interstate forecasting, this allocation determined the destinations of outbound interstate movements or the sources of interstate inbound movements.

This state-to-state allocation results in a mapping of 100 percent of the annual activity, with each partner state as a percentage of the state which was forecast. Figure 25 summarizes the process for allocating annual state-to-state commodity movements. The history of percentage distributions that results was then forecast using rolling weighted averaging. As in the averaging of historical state-commodity directional flows, the most recent observation and that preceding it were weighted by 3 and 2, respectively. This averaging was performed annually in forecasting state-to-state percentages for the years 1977-2000. These percentages were then normalized to obtain final percentage distributions of future state-to-state commodity movements. The 1980, 1985, 1990 and 2000 state-to-state distributions were applied to corresponding state forecast tonnages to obtain state-to-state tonnage forecasts.

Subregional-to-Subregional Commodity Movements

Historical activity of both interstate and intrastate commodity movements at the subregion-to-subregion level was analyzed to develop distributions which are applied to the state pair movements to allocate subregion-to-subregion movements. The subregion-to-subregion allocation process is graphically shown in Figure 26. As in the case of state-to-state movements, a normalized rolling weighted average was employed to forecast future subregion-to-subregion movement distributions. The subregion-to-subregion allocation of commodity movements

TABLE 14-2

COMPARATIVE COMPOUNDED ANNUAL GROWTH RATES

PRELIMINARY AND REVISED BASELINE FORECASTS*

	Growth					Percent Share of Total Trade			
	Historical 1969-1976	Preliminary 1976-2000	Revised 1976-2000	Preliminary 1980-2000	Revised 1980-2000	Historical		Forecast	
						1969	1976	Preliminary 2000	Revised 2000
Cash Grains	10.8	2.7	2.3	2.4	2.3	5.9	11.2	10.2	10.8
Iron and Non-ferrous Ores	7.9	4.3	4.2	5.1	5.1	1.1	1.6	2.1	2.3
Bauxite and Aluminum Ores	--	4.6	(2.0)	4.2	(2.2)	0.0	.1	.1	--
Coal	2.0	1.5	2.3	1.3	2.2	30.6	32.3	22.0	28.9
Crude Petroleum	(10.0)	2.6	1.6	2.4	2.0	19.0	8.2	7.4	6.2
Petroleum Products	4.9	3.5	3.2	3.5	3.5	12.7	16.3	17.6	18.0
Industrial Chemicals	.8	5.6	3.8	5.3	3.9	5.3	5.2	9.1	6.6
Ag. Chemicals/Fertilizers	7.5	4.8	6.5	4.7	6.6	1.0	1.5	2.2	3.5
Milled Grain	16.2	3.3	5.7	2.7	5.3	.7	1.9	1.9	3.6
Lumber and Wood	(.4)	6.5	5.4	5.8	5.4	.5	.4	1.0	.8
Sugar & Molasses	(1.0)	4.3	3.5	4.0	3.4	.4	.3	.4	.4
Primary Metal Products	(1.1)	4.1	3.6	3.4	3.0	1.7	1.4	1.8	1.7
Fabricated Metal Products	(5.0)	3.8	3.8	3.8	3.8	.2	.1	.2	.2
Scrap Metals	10.9	2.2	2.2	4.3	4.3	.2	.4	.3	.3
Construction Materials	(.5)	4.4	1.8	4.2	2.0	12.1	10.7	14.2	8.5
Mining Products	(1.2)	1.3	.8	1.2	.7	4.6	3.9	2.5	2.4
Non-Durable Manufactures	7.4	3.0	3.0	4.2	4.1	.3	.5	.5	.5
Durable Manufactures	6.2	2.7	2.3	4.0	3.8	.5	.7	.6	.6
Waste and Scrap	5.4	4.3	2.5	3.9	2.4	1.0	1.3	1.7	1.2
Waterway Improvement Materials	(.3)	6.3	5.1	5.2	4.4	2.1	1.9	3.9	3.2
Total System		3.1	2.8	3.0	2.8	100.0	100.0	100.0	100.0

*Designated Direction and Intrastate

Source: Temple, Barker & Sloane, Inc.

was then applied to the state-to-state forecast of commodity movements to provide a subregion-to-subregion base forecast of commodity movements for the Mid-America states.

BASELINE FORECAST REVIEW

After review of the preliminary baseline forecast, a small number of flows were adjusted to reflect certain historical trends at the state level. The majority of these adjustments were downward, consistent with historical decreases in activity that result from a combination of factors, not all economic in nature. Sources and availability, commodity life cycle, competitive modes, stockpiling and other procurement policies can have a dominant effect upon a commodity waterborne trade activity which is not always recognized. Table 14-2 shows a comparison of preliminary and revised baseline forecasts.

High, Medium and Low Baseline Forecasts

Complementary forecasts for high and low economic development in the Mid-America Region were prepared. Inflation, capital investment, productivity and pollution controls were among the major relationships varied. The assumption made for each of these items to generate the high and low growth scenarios are summarized in Table 14-3.

TABLE 14-3

ASSUMPTIONS FOR DEVELOPMENT OF ECONOMIC GROWTH SCENARIOS

Parameter	Low Growth Scenario	High Growth Scenario
Inflation	High rate of inflation (6%)	Low rate of inflation (3½ - 4%)
Capital Investment	Low rate of investment (2½ - 3%)	High rate of investment (4½%)
Productivity	Low increase in productivity	High increase in productivity
Pollution and Vehicle Emission Control	Stringent enforcement	Limited enforcement

Their impact upon the econometric forecast and, in turn, upon waterborne trade resulted in a total range of outcomes of approximately 27 percent, as shown in Figure 27.

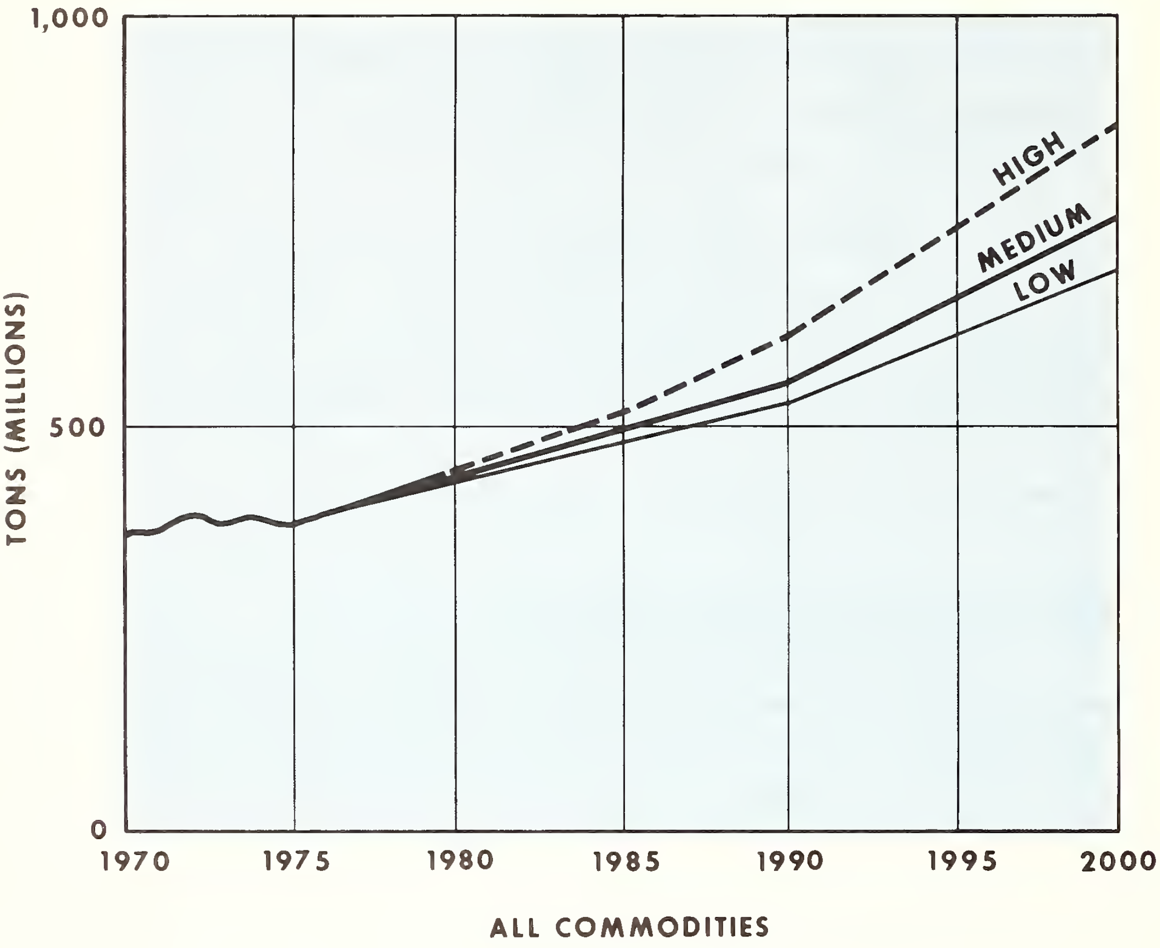

FIGURE 27 - HIGH, MEDIUM AND LOW BASELINE FORECASTS

ADJUSTMENTS TO BASELINE FORECAST

The baseline forecast is based upon well established historical trends. Development of the final waterborne commodity forecast involved adjustments to the baseline forecast to reflect the influence of factors which will have a significant impact upon the waterway system and represent significant departure from historical patterns. These included: new waterway projects; western coal shipments; lock capacity constraints; and the waterway user charge. On balance, the new waterway projects and western coal shipments increase the tonnage in the study area. In contrast, the lock capacity constraints and waterway user charge divert traffic off the waterways.

Waterway Projects

In addition to the many components of the waterways system which are currently in operation and respond to historical trends in economics and demographics, a total of eight projects -- newly completed, under construction or authorized for construction -- will commence operation during the forecast period. These waterway projects were identified (see Chapter 6) and tonnage forecasts available from published or authoritative sources, including the Corps of Engineers, were incorporated into the Mid-America trade forecast in a manner consistent with the overall trade forecast. Table 14-4 presents these projects and their forecast characteristics.

Western Coal

Western coal transshipments from unit trains to hopper barges were also added to the forecast. These movements are expected to consist of low sulphur, low btu coal from Wyoming and Montana brought into the Mid-America Region by the Burlington Northern Railroad. In addition to existing transshipment at Havana and Metropolis, Illinois, new transshipment facilities at St. Louis, Metropolis and Minneapolis are projected to contribute more than 70 million tons of coal by the year 2000, as shown in Figure 28.

TABLE 14-4

WATERWAY PROJECT FORECASTS

Project Name	Project Status	Forecast Years	Forecast Type
Arkansas River	Operating	1980, 1985 1990, 2000	Origin and Destination of Cash Grains from Oklahoma
Kaskaskia River	24 Miles Completed	1980, 1985 1990, 2000	Send or Receive
Tennessee-Tombigbee Waterway	10 Miles Under Construction	1985, 1990 2000	Origin and Destination by Bureau of Economic Analysis Region
Red River-Mississippi River to Shreveport, Louisiana	Authorized	1985, 1990 2000	Send or Receive
Red River-Shreveport, Louisiana to Dangerfield, Texas	Authorized	1990, 2000	Send or Receive
Yazoo River	Authorized	1990, 2000	Send or Receive
Cooza River	Authorized	1990, 2000	Send or Receive
Ouachita River (to Camden, Arkansas)	Authorized	1985, 1990 2000	Send or Receive

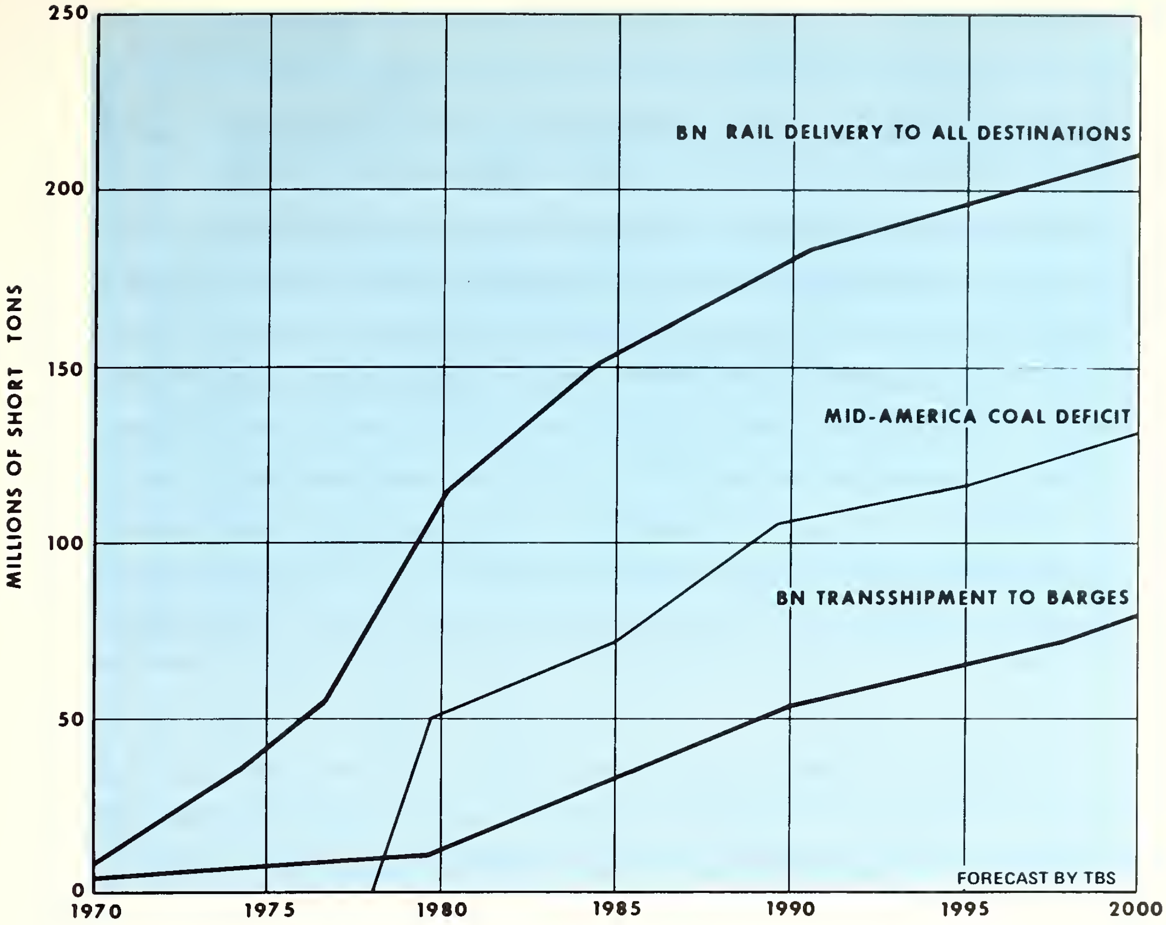

FIGURE 28 - COAL DELIVERY AND TRANSSHIPMENT BY BURLINGTON NORTHERN RAILROAD

Lock Capacity and Forecasts of Diversion

The baseline forecast was used to analyze lock capacities and the extent, composition and impact of any future diversion of cargoes from the waterways. Based upon estimated annual cargo capacities (see Chapter 9), tonnage in excess of the capacity was diverted in four increments of increasing commodity volume and decreasing cargo value. Assumptions describing the rehabilitation of each constrained lock and the eventual recovery of commerce were varied in the high, medium and low forecasts.

The underlying principle for the determination of diversion of traffic from each of the 13 constrained locks is that higher value goods can be more easily diverted to and absorbed by alternative transportation modes because they generally incur higher inventory costs during delays, have transportation costs that are a smaller portion of their total value, move in smaller more easily re-routed lot sizes and are subject to less institutional transportation momentum. In view of the close relationship between a commodity's value per ton ($/ton) and its share of total waterborne traffic, volume was used as a surrogate for value. The diversion of traffic was based on four sets of commodity groups ranked by share of traffic and susceptibility to diversion.

Under the medium baseline scenario, it was assumed that the capacity constraint would be eliminated (e.g. construction of an improved lock) 15 years following the year in which demand exceeds capacity; within five years after the improvement the lock recovers 75 percent of the diverted traffic. For the low growth scenario, there is zero recovery of diverted traffic. Under the high growth scenario the capacity constraint is eliminated at the end of 10 years and 95 percent recovery of diverted traffic is achieved five years thereafter.

It was assumed that all of the traffic diverted off the waterways by the constrained locks was absorbed by railroads, which would have the ability to absorb this traffic. Mainline infrastructure (single and multiple track, signal system, etc.) was analyzed for each of the 89 subregions in the north-south and east-west corridors. Almost without exception, the mainline segments in the Region can absorb a doubling of freight traffic with only localized investment in centralized track control signal systems.

Waterway User Charge

In October 1978 the Inland Waterways Revenue Act of 1978 was enacted. The act imposes a tax on fuel used in commercial transportation on the inland waterways in accordance with the following schedule:

October 1980 - September 1981	4 cents/gallon
October 1981 - September 1983	6 cents/gallon
October 1983 - September 1985	8 cents/gallon
After September 1985	10 cents/gallon

The waterborne commodity forecasts for the Mid-America Ports Study were prepared well in advance of the enactment of the above schedule (approximately one year before enactment) and at a time when the issue of the waterway user charge was surrounded in controversy and confusion. The matter was tied in with appropriations for improvements to Locks and Dam 26 and was the subject of extensive Congressional debate.

It was not certain at the time this forecast was in preparation that a user charge would be levied.

Despite the uncertainty, it was decided with Mid-America Steering Committee review and approval, to incorporate a user charge into the development of the final waterborne commodity forecast. Based upon available information at that time, it was assumed that a user charge would be imposed in steps during the forecast period and have a modest diversionary impact upon waterborne commerce; the levels of the charge and the estimated diversionary impact are summarized below:

Year	Assumed Charge (¢/gallon)	Waterborne Commodity Diversion (% of total flow)
1980	5	1%
1985	12	3%
1990 to 2000	20	6%

The estimated percent of waterborne commerce diverted to other modes is based upon studies prepared for the Office of the Secretary, U.S. Department of Transportation.*

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* For example, see Anderson, et.al., Modal Traffic Impacts of Waterway User Charges (Volumes I and II), Final Report, August 1977 (Report No. DOT-TSC-OST-77-36, I and II), Washington, D.C.

Though the assumed user charge schedule differs from the schedule enacted by Congress, the differences are not significant as they relate to this study, particularly the extent to which these differences affect the estimated share of commerce diverted off the waterways.

FINAL FORECAST SUMMARY*

The Mid-America forecast of waterborne commerce was prepared on a subregion-pair basis and employed at the subregion level for purposes of determining port requirements. The forecast is presented below in summary form to provide a general overview of the forecast along with a discussion of the impact of waterway and institutional constraints on the forecast. Appendix H contains the state subregional forecasts by commodity group.

Overall, traffic will double between 1976 and the year 2000, increasing from 624 million to 1,270 million short tons, equivalent to an average annual growth rate of about 3 percent.

The final summary forecast by river system, which reflects constraints, is shown in Table 14-5. The impact of lock constraints and the waterways user charge upon traffic in the Mid-America Region is summarized in Table 14-6. The diversion of waterborne tonnage is initially due to waterways user charge-related modal shifts, but by 1985 lock constraints become the major cause of diversion of traffic from the waterways;

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* The tabular summaries and discussion of forecast waterborne commerce volumes presented in this chapter represent the sum of a state's inbound (from out-of-state), outbound (to out-of-state) and intrastate commodity movements. In contrast, to be consistent with the graphics of Chapter 4 , the forecast volumes depicted in Figure 29 represent total state waterborne commodity receipts, which is the sum of a state's inbound (from out-of-state) and intrastate movements. Though the absolute magnitude of the two volumes differ, any discussion of relative change (i.e., percent growth) is applicable to both depictions of forecast waterborne commerce.

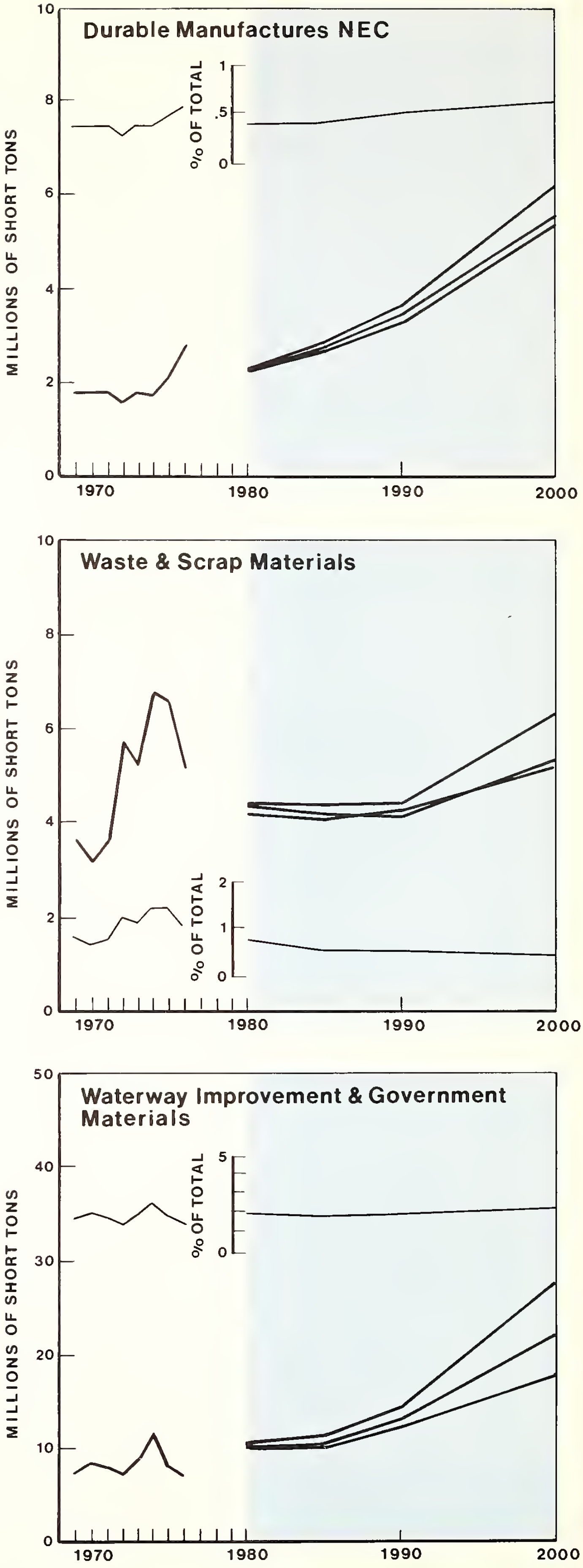
TABLE 14-5

SUMMARY OF WATERWAY TRAFFIC BY RIVER SYSTEM
INBOUND, OUTBOUND AND INTRASTATE
(millions of short tons)

	1969	1970	1971	1971	1973	1974	1975	1976	1980	1985	1990	2000	1976-2000 Average Annual Growth
Alabama Waterways (Including Appalachicola, Chattahoochie and Flint River	24.4	24.6	27.6	33.7	35.0	37.2	33.5	37.8	45.8	72.1	98.2	144.9	5.8
Gulf Coast and Intracoastal Waterways (East and West)	64.3	63.4	68.6	68.1	62.0	59.1	58.7	60.5	58.9	59.2	61.1	82.9	1.3
Lower Mississippi River - Cairo to Mouth (Including Yazoo and White/Black Rivers)	158.3	170.2	174.4	181.2	178.7	188.7	188.2	199.3	230.5	269.8	315.6	457.7	3.5
Upper Mississippi River - Minneapolis to Cairo (Including Kaskaskia and St. Croix Rivers)	49.3	53.8	54.7	61.0	54.4	62.2	63.4	65.4	111.8	130.6	149.3	198.7	4.7
Arkansas/Verdigris River	0.0	3.7	4.2	5.2	4.6	5.8	4.9	6.2	7.9	11.4	14.8	24.3	5.9
Red River	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	3.2	3.8	0.0
Ouachita River	.7	.6	.6	.8	.7	.9	1.0	1.4	1.2	1.4	1.6	2.3	2.1
Illinois River	58.6	61.1	58.6	63.0	65.2	64.0	63.9	61.5	67.6	66.6	66.6	75.0	.8
Ohio River (Including Allegheny, Monogahela, Kanawha, Green and Kentucky Rivers)	222.7	230.0	227.7	235.8	223.9	227.5	227.5	237.4	240.4	296.5	316.0	389.6	2.1
Tennessee and Cumberland Rivers	29.4	30.5	33.3	36.6	37.5	36.0	36.7	35.2	42.7	49.0	51.4	60.3	2.3
Missouri River	8.5	8.8	8.5	8.4	7.7	8.7	6.6	7.0	7.8	8.1	8.8	11.6	2.1
Total System	616.2	646.7	658.2	693.8	669.7	690.1	684.4	711.7	814.6	966.6	1086.6	1451.1	3.0

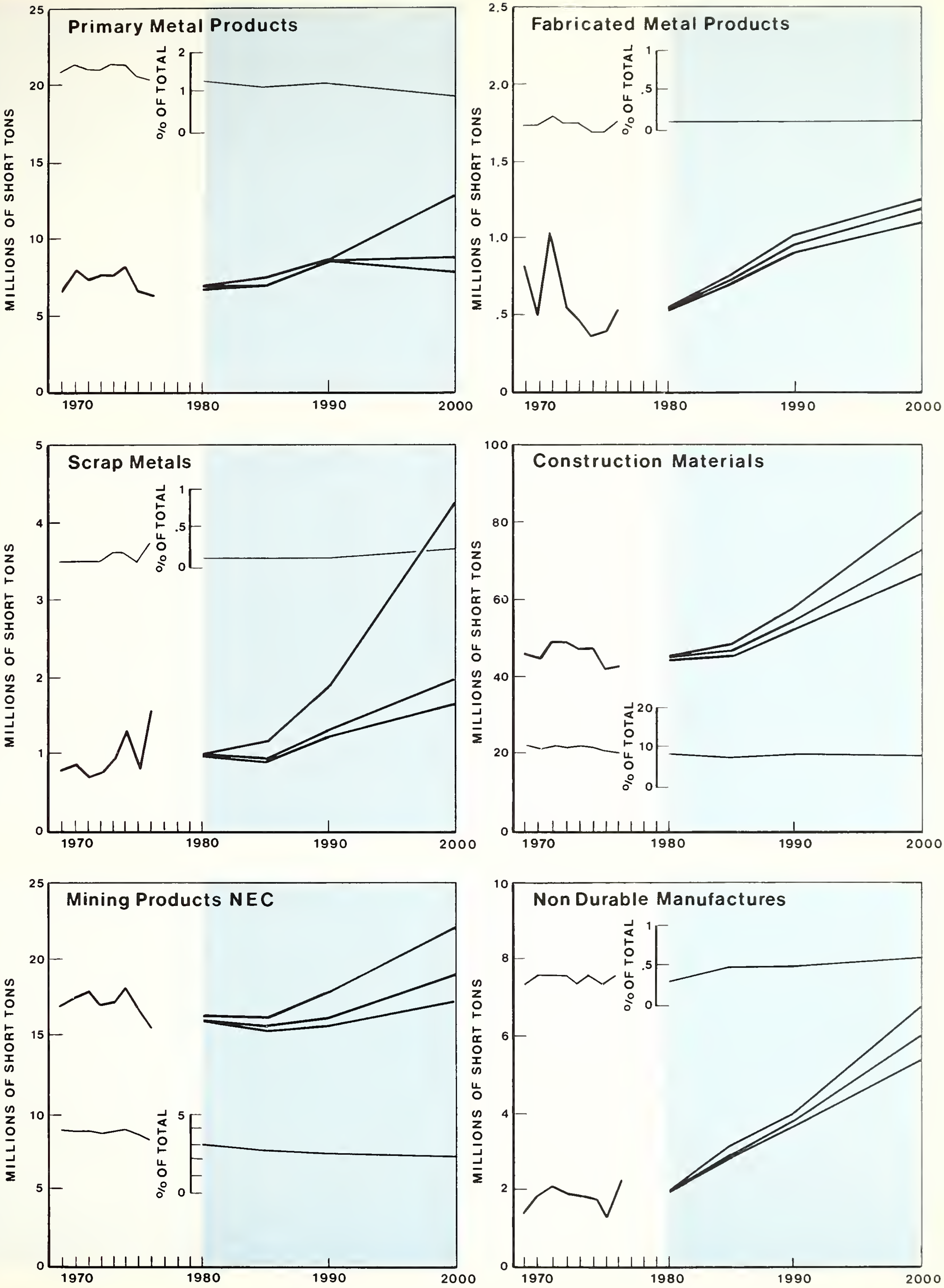
Note: Indiana included.

Source: Temple, Barker and Sloane, Inc.



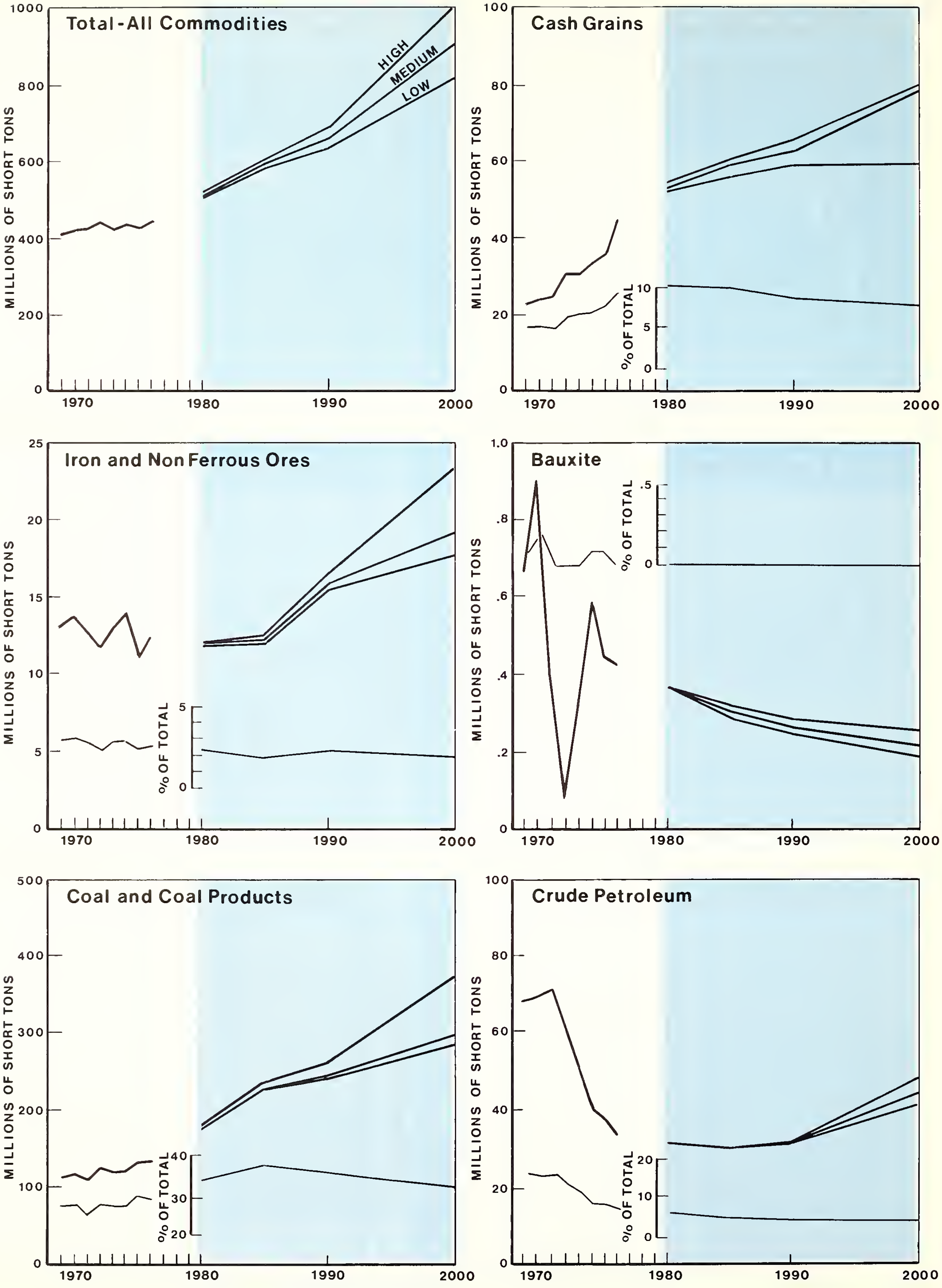
FORECAST BY TBS
GRAPHIC PRESENTATION BY TAMS

FIGURE 29
FORECAST WATERBORNE COMMODITY VOLUMES



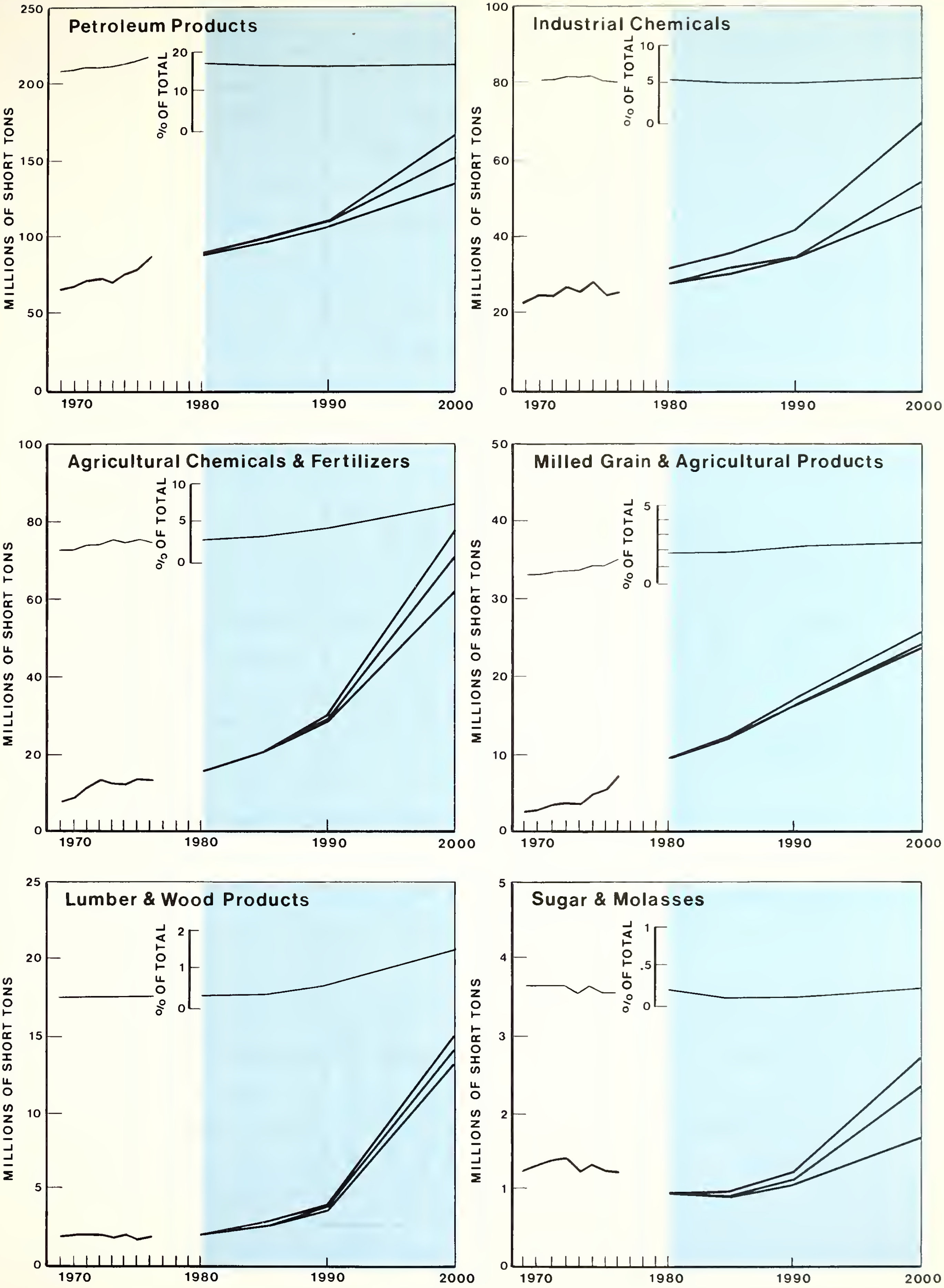
FORECAST BY TBS
GRAPHIC PRESENTATION BY TAMS

FIGURE 29
FORECAST WATERBORNE COMMODITY VOLUMES



FORECAST BY TBS
GRAPHIC PRESENTATION BY TAMS

FIGURE 29
FORECAST WATERBORNE COMMODITY VOLUMES



FORECAST BY TBS
GRAPHIC PRESENTATION BY TAMS

FIGURE 29
FORECAST WATERBORNE COMMODITY VOLUMES

TABLE 14-6

COMPARISON OF CONSTRAINED AND UNCONSTRAINED TRAFFIC FOR THE MID-AMERICA STATES

Inbound, Outbound and Intrastate

(millions of short tons)

	1976	1980	1985	1990	2000
Unconstrained	624.3	731.4	930.6	1,100.9	1,516.7
Constrained	624.3	714.6	846.5	947.3	1,270.0
Diverted Traffic	0.0	16.8	84.1	153.6	247.0
Share Diverted	0%	2%	9%	14%	16%

Source: Temple, Barker & Sloane, Inc.

the overall average annual growth rate in traffic is reduced by almost 20 percent.

The impact of diversion upon individual states is presented in Table 14-7. Illinois waterborne trade loss represents the largest share of lost traffic for all the states. This is largely the result of congestion on the Illinois Waterway at Starved Rock Lock/Dam, which results in a loss of nearly 20 million tons. The latter, combined with Marseilles Lock and Lock/Dam 26, also has major implications for Louisiana which loses a similar amount of commerce. Tennessee trade is negatively affected by constraints at Kentucky Lock/Dam with significant amounts of coal tonnage being lost to alternative logistical solutions.

Several states that are presently relatively small users of the waterways will examine high growth rates. Oklahoma's future use of the Arkansas River is expected to generate an annual average growth rate of 6.9 percent between 1976 and 2000, while its downriver partner Arkansas is forecast to support an average annual traffic increase of 6.6 percent. The Tenn-Tombigbee Waterway will be a major factor in Alabama's projected 5.0 percent average annual growth rate. Wisconsin is projected to experience a 5.7 percent growth rate. Minnesota's movements of grain and western coal contribute to a forecast 4.8 percent average annual growth rate.

Forecast growth in some of the major trading states is closely linked to the system-wide average annual growth of waterway traffic between 1976-2000 of 3 percent; these states include Louisiana and Ohio.

Locks and Dam 26, the New Orleans Inner Harbor Navigation Canal Lock, and Marseilles Lock and Dam on the Illinois Waterway are constrained from the near outset of the forecast period. These facilities are accordingly projected to recover portions of their trade during the late 1990's in the medium scenario. For this reason, the full impact of lock congestion upon certain states is reduced by the year 2000.

TABLE 14-7

MEDIUM SCENARIO

COMPARISON OF CONSTRAINED AND UNCONSTRAINED TRAFFIC BY STATE

Inbound, Outbound and Intrastate
(millions of short tons)

State	Total 1976 Traffic	Unconstrained 2000 Traffic	Constrained 2000 Traffic	Diverted 2000 Traffic	Share 2000 Traffic Diverted	Principal Cause of Diverted Traffic
Alabama	38.9	156.5	126.5	30.0	19.0%	Inner Harbor Lock, User Tax
Arkansas	10.2	51.4	47.9	3.5	7.0	User Tax
Illinois	81.5	200.6	149.6	51.0	25.4	Illinois Waterway, L/D26, User Tax
Iowa	9.5	23.2	19.9	3.3	14.2	L/D26
Kansas	0.1	0.2	0.2	0.0	7.0	Waterway User Tax
Kentucky	54.0	98.4	81.5	16.9	17.0	Gallipolis L/D, Kentucky L/D, User Tax
Louisiana	191.5	434.1	378.5	55.6	13.0	Inner Harbor, L/D26, User Tax
Minnesota	15.8	55.9	49.2	6.7	12.0	L/D26, User Tax
Mississippi	23.7	79.4	68.1	11.3	14.0	Waterway User Tax
Missouri	29.3	86.8	79.1	7.7	9.0	Waterway User Tax
Nebraska	1.2	3.0	2.7	0.3	10.0	Waterway User Tax
Ohio	40.8	99.1	85.9	13.2	13.0	Gallipolis L/D, User Tax
Oklahoma	1.6	8.7	8.0	0.7	8.0	User Tax
Pennsylvania	44.2	65.1	54.2	10.9	17.0	Gallipolis L/D, User Tax
Tennessee	30.4	80.0	54.3	25.8	32.0	Kentucky L/D, User Tax
West Virginia	49.0	63.4	55.0	8.4	13.0	Gallipolis L/D, User Tax
Wisconsin	2.6	10.9	9.9	1.0	9.0	User Tax
Total	624.3	1,516.7	1,270.0	247.0	16.0	

NOTE: Numbers may not total due to rounding.

Source: Temple, Barker & Sloane, Inc.

Arkansas, Kansas, Mississippi, Missouri, Oklahoma, Nebraska and Wisconsin experience diversions of trade in 2000 that are only slightly in excess of that caused by the waterway user tax. States along the Ohio River and Upper Mississippi lose significant shares of traffic as the result of Gallipolis, Kentucky and Locks and Dam 26 congestion.

In Table 14-8 the relative impact of diversion upon the 20 Mid-America commodity groups can be seen. The low value, high volume commodities experience the least percentage diversion, while high value, low volume commodities experience the highest relative diversion.

The vulnerability of metal products, sugar, ores, waste and scrap is notable. Movements of crude oil along the Lower Mississippi are insensitive to lock constraints as are construction materials, whose movements along the Missouri River, Ohio River and Lower Mississippi are also generally unaffected by lock congestion. Cash grain movements rebound by 2000 as congestion at Locks and Dam 26 is alleviated. Coal movements continue to experience diversion at Kentucky Lock and Dam despite some recovery at Locks and Dam 26 and on the Illinois Waterway at Marseilles.

Agricultural chemicals and fertilizers is a group expected to experience a high average annual growth rate of 6.8 percent, more than twice the rate for total study area traffic. Milled grains and coal are forecast to increase at average annual rates of 5.3 and 3.5 percent, respectively. Petroleum products and cash grains traffic are expected to grow at average annual rates of 2.6 and 2.4 percent, respectively.

Figure 29 shows final high, medium and low forecast waterborne commerce volumes by commodity group for total 17-state traffic receipts, the figure also shows each commodity group's share of total study area traffic.

TABLE 14-8

MEDIUM SCENARIO

COMPARISON OF CONSTRAINED AND UNCONSTRAINED TRAFFIC BY COMMODITY GROUP

Inbound, Outbound and Intrastate
(millions of short tons)

Commodity Group	Total 1976 Traffic	Unconstrained 2000 Traffic	Constrained 2000 Traffic	Diverted 2000 Traffic	Share 2000 Traffic Diverted
Cash Grains	84.4	177.0	148.8	28.2	16.0%
Iron & Non-Ferrous Ores	14.7	34.2	22.2	12.0	35.0
Bauxite & Aluminum Ores	0.8	0.5	0.4	0.1	20.0
Coal and Coal Products	185.6	505.0	420.7	84.3	17.0
Crude Petroleum	39.9	58.0	54.4	3.6	6.0
Petroleum Products & Lubricants	116.6	234.9	208.9	26.0	11.0
Industrial Chemicals	32.9	87.1	72.0	15.1	17.0
Agricultural Chemicals/Fertilizers	18.1	102.6	86.7	15.9	15.0
Milled Grains & Agricultural Products, NEC	13.7	54.0	47.1	6.9	13.0
Lumber & Wood Products	2.5	8.3	16.1	2.2	12.0
Sugar & Molasses	1.6	5.6	3.7	1.9	34.0
Primary Ferrous & Non-Ferrous Metal Products	10.3	28.7	13.5	15.2	53.0
Fabricated Metal Products	0.9	2.6	1.7	0.9	35.0
Scrap Metals	2.2	5.0	2.9	2.1	42.0
Construction Materials	55.1	103.5	94.6	8.9	9.0
Mining Products, NEC	20.3	25.8	22.6	3.2	12.0
Non-Durable Manufactures	3.4	11.0	9.0	2.0	18.0
Durable Manufactures	3.3	8.8	5.6	3.2	36.0
Waste & Scrap Materials	5.6	12.6	6.1	6.5	52.0
Waterway Improvement Materials	11.6	41.8	32.3	9.5	22.0
Total	623.5	1,517,0	1,270.0	247.0	16.0%

NOTE: Numbers may not total due to rounding.

Source: Temple, Barker & Sloane, Inc.

CHAPTER 15

PORT FACILITY HANDLING CAPACITY

The efficient operation of Mid-America's inland waterway system is dependent upon the operation of both the port terminal facilities and the lock and channel network. The capacities of each should be in balance with one another to achieve optimum systemwide cargo throughput at minimum transport cost and delay. The primary objective of this study is port facility development. In this regard, terminal capacity analyses are paramount, though lock capacity evaluations as described in earlier chapters were also performed to identify potential constraints along the waterways.

This chapter: (1) describes the methodology utilized to estimate the cargo handling capacities of Mid-America terminal facilities, and (2) presents a summary of findings. A comparison of the capacity estimates with projected waterborne commerce levels is performed and described in the following chapter.

Cargo handling capacities by MarAd Facility Cargo Type Code (see Table 15-1) were estimated by subregion for the terminals in the Facility Inventory. Loading and discharging capacities were calculated separately for each facility cargo type, with the exception of general cargo items for which loading and unloading rates do not vary significantly.

First, existing cargo handling capacities were estimated individually for each inventoried facility. These capacities were then aggregated on a subregional basis to facilitate comparison with the subregional commerce forecasts. Loading and discharging capacities were aggregated separately.

The calculation of capacity involved the use of:

- Physical and operational data from the facility inventory;

TABLE 15-1

FACILITY INVENTORY TERMINAL CARGO TYPES

Commodity Group Code[3]	Code	Facility Description
13,17,18)	(A	General Cargo Only
)	(B	Passenger/General Cargo[1]
NA	C	Passenger Only[2]
10	D	Wood and Wood Products
4	E	Coal and Coke Products
2	F	Ores and Concentrates
15,16,19,20	G	Non-metallic Minerals
12	H	Iron; Steel and Mill Products
8	I	Fertilizers (Nitrates, Phosphates, Potash)
5	J	Crude Petroleum
6)	(K	Refined Petroleum Products
6)	(L	Liquefied Natural Gas
6)	(M	Liquefied Propane Gas
2	N	Liquefied Bulk Ores (Nickel, Cobalt,Sulphides)
1,9	O	Grain
11	P	Bulk Raw Sugar
3	Q	Bauxite and Aluminum Ores
7)	(R	Liquefied Chemicals and Allied Products
7)	(S	Other
11	T	Molasses
7	U	Caustic Soda
14	V	Scrap Metal
NA	W	Refrigerated

---

[1] Combined with Type "A"

[2] No Cargo Handling Capacity Estimated

[3] See Chapter 4

- Additional operational data developed through interviews with terminal operators and Steering Committee members in the 17 participating states;

- The usage of capacity equations; and,

- Consultant judgment.

Figure 30 summarizes the capacity methodology.

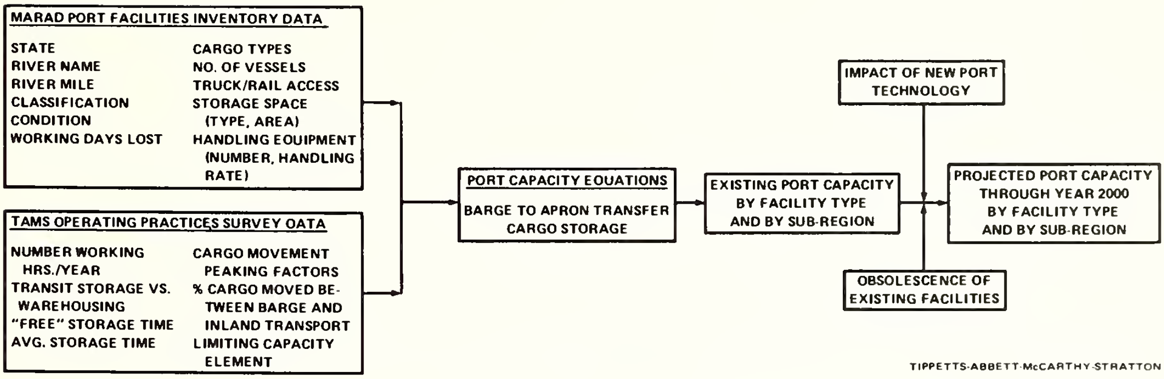

MARAD PORT FACILITIES INVENTORY DATA
STATE
RIVER NAME
RIVER MILE
CLASSIFICATION
CONDITION
WORKING DAYS LOST
CARGO TYPES
NO. OF VESSELS
TRUCK/RAIL ACCESS
STORAGE SPACE (TYPE, AREA)
HANDLING EQUIPMENT (NUMBER, HANDLING RATE)
TAMS OPERATING PRACTICES SURVEY DATA
NUMBER WORKING HRS./YEAR
TRANSIT STORAGE VS. WAREHOUSING
"FREE" STORAGE TIME
AVG. STORAGE TIME
CARGO MOVEMENT PEAKING FACTORS
% CARGO MOVED BETWEEN BARGE AND INLAND TRANSPORT
LIMITING CAPACITY ELEMENT
PORT CAPACITY EQUATIONS
BARGE TO APRON TRANSFER
CARGO STORAGE
EXISTING PORT CAPACITY BY FACILITY TYPE AND BY SUB-REGION
IMPACT OF NEW PORT TECHNOLOGY
OBSOLESCENCE OF EXISTING FACILITIES
PROJECTED PORT CAPACITY THROUGH YEAR 2000 BY FACILITY TYPE AND BY SUB-REGION
TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 30 - CARGO HANDLING CAPACITY METHODOLOGY

The Operational Practices Survey

Consultant staff visited terminal facilities and local port planning and development agencies in each state and in practically all cities handling over one million tons of cargo; interviews were conducted with terminal operators to gather representative data on their terminals as well as information on the business milieu within which each terminal operates.

Over 70 terminals in 30 cities were visited. Those visited are summarized below by the: (1) institutional structure of their operation and ownership; and (2) commodities handled.

(1) Institutional Structure	Number Visited
Public Ownership/Public Authority Operation/Public Use	6
Public Ownership/Private Operation/ Public Use	8
Public Ownership/Private Operation/ Private Use	1
Private Ownership/Private Use	26
Private Ownership/Public Use	24
Not Categorized	6

(2) Commodities Handled		
Grain:	Ship and Receive	5
	Ship Only	14
	Receive Only	1
Coal:	Ship Only	8
	Receive Only	8
Other Dry Bulk:	Ship and Receive	23
Liquid Bulk:	Ship and Receive	20
General Cargo:	Ship and Receive	21

Site visits were coordinated with the state representatives to the Steering Committee so that a representative profile of operations in the study area would be obtained. Data collected from terminal operators for use in the capacity equations included information on:

- Cargo Peaking;
- Working Hours;
- Berth Utilization;
- Storage space, and transshipment and storage time; and
- Proportion of cargoes directly transshipped.

The above factors can vary significantly from commodity to commodity and from state to state, let alone subregion. In view of this and the relatively small sample, representative values for groups of states based upon a tabulation of survey results were selected for use in the capacity calculations. The values are summarized in Table 15-2 and the significance of each factor in the capacity calculations is described below.

Capacity Methodology and Equations

The calculation of the physical capacity of a transportation facility is meaningful for the planning process when presented in terms of the level of service provided. Capacity must be related to the speed, cost and flexibility of the service.

A distinction must be made between a "theoretical" capacity or the maximum volume that could be physically accommodated, and a "practical" or design capacity which represents the volume that can ordinarily be realized under prevailing conditions. For example, the number of working hours that a port facility is in operation is one of the elements that causes a distinction between a maximum theoretical and a practical capacity. A terminal facility may generally operate, for example, on an eight-hour day, five-day week schedule, with little overtime. Theoretically, the capacity could be tripled by operating on a 24-hour basis. The likelihood of a 24-hour operation, however, is dependent upon such factors as the type of facility (public or private), the type of cargo moved, and, probably most importantly, the availability and additional cost of labor.

The capacity methodology must be keyed ultimately to the available study data and study objectives. Various methods have been employed over the years to calculate the cargo handling capacity of terminal facilities. The requirements and perspective of a private terminal operator are different from those of a port authority or a national or international planning agency and the type of capacity calculations that are generally employed by each are different. Techniques vary from "rule of thumb" estimates to analytical approaches involving sophisticated simulation models.

TABLE 15-2
FACTORS FOR FACILITY CAPACITY EQUATIONS

		W	Q		D		Y		R	
	Super * Region	Availability (Hours/Yr.)	Peaking Factor (Avg. Month Tonnage) Peak Mo. Tonnage		Storage Dwell Time (Days)		Percent Cargo Requiring Storage of Total Cargo Handled (%)		Practical Handling Rate Rated Equipment Capacity	
			Load	Unload	Load	Unload	Load	Unload	Load	Unload
General Cargo	1	3700	.95	.95	15	15	.90	.90	.90	.90
	2	3700	.95	.95	30	30	.90	.90	.90	.90
	3	3700	.95	.95	15	15	.75	.75	.90	.90
	4	3700	.95	.95	15	15	.90	.90	.90	.90
Solid Bulk	1	5000	.90	.90	30	70	.85	.85	.85	.70
	2	5000	.90	.90	30	70	.85	.85	.85	.70
	3	5000	.90	.90	20	30	.85	.85	.85	.70
	4	5000	.90	.90	20	30	.85	.85	.85	.70
Liquid Bulks	1	6000	.75	.75	20	70	.95	.95	.90	.90
	2	6000	.75	.75	20	70	.95	.95	.90	.90
	3	6000	.75	.75	20	60	.95	.95	.90	.90
	4	6000	.75	.75	20	60	.95	.95	.90	.90
Grain	1	3000	.50	.50	30	20	.35	.75	.85	.70
	2	3000	.50	.50	30	20	.35	.75	.85	.70
	3	5000	.50	.50	10	6	.35	.75	.85	.70
	4	5000	.50	.50	10	6	.35	.75	.85	.70
Coal & Coke	1	5000	.50	.50	5	60	.85	.85	.85	.70
	2	5000	.50	.50	5	60	.85	.85	.85	.70
	3	5000	.50	.50	20	20	.85	.85	.85	.70
	4	5000	.50	.50	20	20	.85	.85	.85	.70

* Super Regions	States
1	Pennsylvania, Ohio, West Virginia, Kentucky
2	Illinois, Missouri, Kansas, Nebraska, Iowa, Wisconsin, Minnesota
3	Oklahoma, Arkansas, Louisiana
4	Tennessee, Mississippi, Alabama

One of the more unique requirements of the Mid-America Study was the analysis of 1,198 individual facilities. The large volume of data to be manipulated necessitated use of computer techniques. Moreover, reliance had to be placed upon the validity of the inventory data; it was not possible to field check the information, as is common in lesser efforts.

Inventory data for each facility made it possible to estimate both storage area capacity and berth transfer capacity. Data were not provided, however, on the hinterland transfer of cargo and no estimate of the terminal capacity associated with this movement was made which, under certain circumstances, might be the controlling factor affecting terminal capacity.

A far more serious concern is the fact that, at least in certain of the states, the inventory contains less than the universe of facilities; one state for example inventoried only publicly-owned terminal facilities, while in another state the smaller, liquid bulk terminals were excluded. Inasmuch as the collection of facilities in a state or subregion is not a homogenous set, it is not possible to expand a facility sample even if one knows the total number of facilities. Adjustments for missing terminals could not, therefore, be made at this stage of the analysis.*

Some terminal facilities are "public use" facilities while others are retained expressly for the private use of one or more selected users; in the latter case the commodity is usually processed or utilized at the waterfront site. The commodity forecasts and capacity estimates are not separated into public and private components, even though public and private facilities have different operating patterns. At private facilities, excess cargo handling capacity may exist but is only available for the owner of the facility; it is not transferable to another user. Aggregating private and public facilities in the capacity analysis, therefore, may slightly overstate available capacity.

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* The adjustment to existing capacity levels to compensate for "missing" data is described in Chapter 16.

The following sections describe the application of the terminal capacity equations.

Vessel To Apron Transfer Capacity

The annual vessel to apron throughput capacity may be expressed as:

C_B = H x G x W x B x P x Q x R, where

C_B = Annual vessel to apron transfer capacity, Short Tons (ST)

H = Average cargo handling rate per hour per unit of handling equipment (ST/hour)

G = Number of units of handling equipment per berth

W = Number of working hours per year

B = Number of berths at which loading/unloading operation may be carried out at any given time

P = Practical berth occupancy (%)

Q = Cargo Peaking Factor (%)

R = Practical Handling Rate divided by rated equipment capacity

Since barge loading and discharging rates vary significantly for dry bulks, liquid bulks and grains, the vessel to apron transfer capacity for loading and discharging of these cargoes were estimated separately. No distinction was made between loading and unloading rates for calculation of general cargo capacity.

Cargo Handling Rates (H)

For all dry bulk , liquid bulks and grains, average hourly handling rates were taken from the loading and discharge rates indicated on the MarAd inventory form in data elements Nos. 277-282, 320-325 and 362-367, respectively. The indicated rated equipment capacities were reduced by the factor "R" to derive average "practical" handling rates. In addition, where the units are shown in long tons, 100's of barrels, and 1,000's of bushels for dry bulk, liquid bulk and grains, respectively, they were converted to short tons to facilitate comparison with the commerce forecasts.

For the various commodity groups that comprise the general cargo category, estimates are made of hourly handling rates (in short tons) through information obtained from the interviews of terminal operators and through the judgment and experience of the Consultant. Average hourly handling rates were estimated as 25 short tons per hour for mixed break-bulk and bagged cargo; 100 short tons per hour for wood and wood products; 75 tons per hour for iron and steel products, and 60 tons per hour for scrap metals.

Number of Units of Handling Equipment Per Berth (G)

It was assumed that only one piece of loading or discharging equipment per barge will be used. In the states of Alabama and Louisiana, where inland and ocean going movements interface, an average of three barges handling general cargo may be loaded or discharged simultaneously per berth, and the capacity calculations were performed on this basis.

Number of Working Hours Per Year (W)

The annual number of working hours per year shown in Table 15-2 were used in the capacity estimates. The number varies from 6,000 hours per year for liquid bulks to 5,000 hours per year for solid bulks to 3,700 hours for general cargoes. While it is recognized that working hours may vary considerably both among and within commodity groups, it was judged that these values are valid representations of average operating conditions.

In estimating annual working hours, the number of days lost through the impact of adverse environmental conditions such as extreme fog or icing were estimated for each state; estimates varied from a high of 17 days for Wisconsin to only one day for Alabama. The number of working days lost due to river current or river stage were taken directly from inventory form data elements 388 and 389 for each terminal.

Number of Berths (B)

The number of berths that can operate at any given time is dependent upon the number of pieces of handling equipment available to load or discharge cargo. The number of units of handling equipment available were determined directly from the MarAd Inventory Forms, data element Nos. 271-273 and 350-352.

Practical Berth Occupancy (P)

It would be impractical for ports to operate at 100 percent berth occupancy inasmuch as excessive, unacceptable delays to waiting barges would result. Diversion to competing facilities, where feasible, would occur before the delay levels associated with 100 percent occupancy would occur. Practical berth occupancy may be defined, then, as the level of occupancy beyond which diversion to competing facilities will occur due to the delays imposed upon waiting vessels or tows. In the absence of competing facilities, practical berth occupancy may be viewed in economic terms as the occupancy level above which the cost of delay time for waiting barges exceeds the cost of upgrading the facility under consideration.

Determination of the practical delay level involves a judgment after consideration of factors such as the time value of tows and cargo, and availability of alternative facilities. Since barge transportation generally involves low cost per ton cargoes, relatively high berth occupancy rates were used. For purposes of this study, practical berth occupancy has been estimated to be the occupancy rate above which the average delay time for a barge would be double the average service time, or the time required to load or unload the barge. Utilizing a random arrival pattern for tows, the practical berth occupancies for barge berths would be as follows:

Number of Berths	Practical Berth Occupancy
1	67%
2	82%
3	87%
4	90%
5	96%

At terminal facilities in Louisiana and Alabama where both ocean-going ships and barges use the same berths, the berth occupancy rate for the barges would be significantly lower than the values shown above, inasmuch as the available berthing space would be shared by both vessel types. It was judged that practical berth occupancy rates for these types of facilities would be approximately one-half of the values shown in the table.

Cargo Peaking Factor (Q)

The cargo peaking factor is included to reflect the fact that cargo flows vary throughout the year and terminals should have adequate capacity to handle at least peak monthly flows. The effective capacity of the terminal is limited by this peaking because the capacity to handle peak demands will be underutilized during periods of lesser activity. The peaking factor is defined as:

$$\frac{\text{Average Monthly Cargo Flows}}{\text{Peak Monthly Cargo Flows}}$$

As shown in Table 15-2, average peaking factors were estimated at 0.95 for general cargoes, .90 for solid bulks (except coal), .75 for liquid bulks, and .75 and .35 for grain unloading and loading, respectively.

Terminal Storage Capacity

The annual storage capacity of a terminal may be expressed as:

$$C_S = \frac{365 \times A \times Q}{L \times D \times Y}, \text{ where}$$

C_S = Annual throughput capacity of the storage facilities (st)

A = Net storage area (ft^2)

L = Average area required to store one unit of cargo (ft^2/unit)

D = Average cargo dwell time (days)

Y = Proportion of total throughput cargo using storage area

Q = Cargo peaking factor

The net storage area (A) divided by the average area required to store one unit of cargo (L) is the amount of cargo that can be stored at any one time or the "instantaneous storage capacity". For dry bulks, liquid bulks and grains, the instantaneous storage capacities, in units of 1,000's of long tons, 1,000's of barrels and 1,000's of bushels, respectively, are indicated directly on the MarAd inventory form. Therefore, in the explanation of these terms which follow, these two factors, "A" and "L", are not discussed for dry bulks, liquid bulks and grains.

Net Storage Area (A)

For each terminal that handles general cargo, inside storage, reefer storage and yard storage are shown on the MarAd inventory form in units of 1,000's of ft^2, and 1,000's of ft^3, and acres, respectively. Reefer storage was converted from units of volume to units of area by dividing by the inside stacking height values indicated in data elements 139-142.

The areas indicated on the inventory forms were reduced by 20 percent to account for "storage" space that is used for aisles and other space not used for actual placement of cargo.

Average Area Per Unit of Cargo (L)

Area requirements per unit of cargo are a function of practical cargo stacking heights and the density of cargo being stored. Cargo stacking heights are available from the MarAd inventory (data element Nos. 139-142) and, for a given mix of cargo, average cargo density may be determined.

Average space per short ton of cargo stored was estimated at 7.5 ft^2 for break-bulk and 4.5 ft^2 for project cargo.

Average Cargo Dwell Time (D)

Average dwell time is the average number of days that the cargo stays in the terminal which, in turn, is a function of the average arrival rate of cargo, by vessel, and the rate of movement to the hinterland by inland transportation. Estimates of average storage times for the various commodity groups vary significantly throughout the country. The representative average values used are summarized in Table 15-2.

Proportion of Cargo Requiring Storage (Y)

A percentage of the cargo passing through a terminal moves directly from the apron to inland transportation; it was estimated that the percentage of cargo requiring storage ranges from 35 percent for grain being loaded to 95 percent for general cargoes.

Cargo Peaking Factor

See reference to Cargo Peaking Factor in the previous section's discussion of Vessel to Apron Transfer Capacity.

CAPACITY AT THE SUBREGIONAL LEVEL

For each terminal facility, the annual vessel to apron transfer and cargo storage capacities were estimated in accordance with the procedures and factors described above. These individual terminal capacities were aggregated by subregion for each of the commodity groups, separately for both inbound and outbound movements. Individual terminal capacities are considered confidential and are not presented in this study; the aggregated subregional values are presented in Appendix J.

The annual capacity of a terminal facility is the average of the storage and apron (transfer) capacities. In cases where there was a significant difference between apron and storage capacity (i.e., where one value exceeded the other by more than a factor of three) capacity was considered to be the lower of the two values.* In cases where the two capacities differed by less than a factor of three, however, the average of the two capacities was used. This average of apron and storage capacity was considered a reasonable representation of facility capacity inasmuch as average and not exact factors were used in the calculations: any one facility's operational characteristics may depart significantly from average or typical figures used in the equations. In instances in which either zero storage or no handling equipment was indicated on the inventory form, the non-zero value was taken as the basis for computing facility capacity.

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* It was judged that many of the cases involving a difference of more than three multiples were caused by errors in the database.

Storage and berth transfer information may be input on the inventory form for up to four categories of commodities - general cargo, dry bulk, liquid bulk and grains. In cases where more than one liquid bulk or dry bulk commodity was handled at one terminal, it was necessary to divide the calculated capacity among the commodities. This division of capacity was approximated by distributing the capacity to each commodity in proportion to the relative tonnage that moved along the inland waterways in 1976.

EXISTING CARGO HANDLING CAPACITIES

Utilizing the techniques described in the preceding sections, the existing cargo handling capacity of the 1,198 inventoried terminal facilities is estimated. The total 17-state Mid-America inland waterborne annual cargo handling capacity is estimated at 2.16 billion short tons divided approximately evenly between loading and unloading capacity.

Missouri, with 445,000 short tons of capacity, or about 20 percent of the study area's total capacity, has the largest statewide cargo handling capability. Illinois with 390,000 short tons of capacity is the second largest state.

Facilities handling liquid bulk petroleum products have a loading and discharging capacity of 520,000 short tons or 25 percent of the area's capacity, making this the largest single commodity group in terms of handling capacity. Crude petroleum facilities with 377,000 short tons of capacity, followed by coal facilities with 350,000 short tons are the second and third largest.

Table 15-3 summarizes the estimated capacities by state and commodity groups. Figure 31 shows state cargo handling

TABLE 15-3

INVENTORIED FACILITIES

ESTIMATED ANNUAL CARGO HANDLING CAPACITY, BY STATE & COMMODITY GROUP

(short tons, 000)

Commodity Group		AL (01)	AS (04)	IL (13)	IA (15)	KA (16)	KY (17)	LA (18)	MN (23)	MS (24)	MO (25)	NB (27)	OH (35)	OK (36)	PA (38)	TN (42)	WV (48)	WI (49)	Totals
Cash and Milled Grains	L*	3,843	7,707	15,916	5,992	1,902	1,575	7,436	10,728	5,524	8,098	2,739	2,040	52	0	4,951	0	338	78,841
	D*	4,902	688	3,363	2,023	0	1,575	30,040	1,922	1,128	1,251	1,524	0	0	0	5,396	0	0	53,812
Iron and Other Ores	L	3,162	252	3,099	0	0	140	389	641	1,416	2	0	342	0	908	91	4,654	0	15,096
	D	64	210	1,691	25	0	140	3,999	564	1,470	0	0	366	0	685	89	4,654	0	13,957
Bauxite and Aluminum Ores	L	82	27	0	0	0	10	2,961	0	0	37	0	25	154	0	62	0	0	3,358
	D	162	27	0	0	0	10	10	0	0	37	0	25	127	0	3	0	0	401
Coal and Coal Products	L	5,698	160	49,433	2,271	0	9,674	9,039	18,085	0	585	0	35,751	1,904	26,535	27,530	12,906	28	199,599
	D	4,065	80	27,943	4,746	0	9,674	3,284	14,964	0	2,106	0	47,070	1,455	10,069	11,329	12,488	9,827	159,100
Crude Petroleum	L	0	148	237	0	0	46	5,658	1,118	139,424	73,376	88	623	0	239	171	218	0	221,346
	D	0	148	281	0	0	46	5,328	1,604	144,921	535	88	334	0	186	262	1,558	0	155,291
Petroleum Products	L	39	468	89,475	1,259	0	1,717	20,773	21,294	1,920	62,517	0	7,128	968	1,269	1,578	1,943	923	213,271
	D	39	468	15,718	14,467	0	1,717	2,076	16,499	7,255	238,088	0	2,440	0	1,423	4,398	2,901	321	307,810
Industrial Chemicals	L	987	4,160	59,397	6,198	161	4,936	13,708	6,743	5,506	45,488	0	2,177	1,564	5,893	14,245	1,043	635	172,841
	D	987	3,694	47,080	5,704	86	4,936	1,425	9,799	5,243	812	554	3,717	1,325	5,406	1,264	44,351	635	137,018
Agricultural Chemicals/Fertilizers	L	999	3,199	3,117	1,654	0	17,951	1,844	8,090	836	239	334	8,911	154	709	81	0	1,520	49,638
	D	1,036	945	2,356	4,378	533	17,951	634	7,136	890	309	543	51	127	523	326	0	0	37,738
General Cargo	L/D	611	0	979	1,023	23	138	5,409	160	917	785	288	679	96	0	293	262	0	11,663
Lumber Products	L/D	962	576	904	745	0	78	383	333	276	52	0	193	0	27	2,326	0	0	6,855
Sugar & Molasses	L	0	0	7,939	216	88	0	50	956	0	295	210	31	48	0	228	0	32	10,093
	D	0	0	7,939	216	88	0	2,685	903	0	296	210	29	0	0	222	0	32	12,620
Primary Metal Products	L/D	760	2,174	6,570	697	101	1,315	902	3,142	1,828	496	276	2,213	419	14,628	8,774	218	0	44,513
Scrap Metal	L/D	0	91	2,375	536	0	214	0	1,927	169	141	0	28	0	1,194	1,052	270	99	8,096
Construction Materials, et al.	L	1,462	1,946	21,765	8,045	86	33,466	6,740	6,871	908	2,890	820	8,612	1,387	10,108	15,142	7,857	230	128,335
	D	2,057	1,842	22,311	5,507	86	33,466	4,011	4,677	3,272	5,076	525	7,367	1,143	7,558	18,233	2,932	1,499	121,562
LPG	L	0	0	131	0	0	19	178	81	677	44	0	0	0	0	20	30	0	1,180
	D	0	0	44	0	0	19	178	89	677	44	0	0	0	0	20	701	0	1,772
Totals	L&D	31,917	29,010	390,063	65,702	3,154	140,813	129,140	138,326	324,257	443,599	8,198	130,152	10,923	87,360	118,086	98,986	16,119	2,161,272

* L = Loading
D = Discharging

capacities. The following discussion highlights the major findings for the five largest commodity groups, which account for over 60 percent of Mid-America's current waterborne commerce.

Petroleum Products and Crude Petroleum

Missouri has about 40 percent of Mid-America's total petroleum product handling capacity, with 300,000 short tons, 70 percent consisting of barge discharging capacity. Minnesota (180,000 short tons) is second, followed by Illinois with slightly over 100,000 short tons. According to the inventory, Mississippi has the largest crude petroleum handling capacity. The fact that both Louisiana and Alabama fail to show up with major handling capacities in either crude or refined capability probably reflects omissions of inventory data.

Grains

This category includes both cash grains and milled grain products. Louisiana, with 37.4 million short tons of grain handling capacity has about 30 percent of the study area's capacity for this commodity group. In the northern portions of the study area, Illinois with 19.3 million short tons capacity ranks second, while Minnesota with about 12 million short tons has the third largest grain handling capacity.

Coal and Coal Products

Illinois has the largest coal handling capacity with 77.3 million short tons (over 60 percent devoted to barge loading) or about 22 percent of the total study area's capacity. Tennessee and Pennsylvania each with about 10 percent of the coal handling capacity rank second and third, respectively.

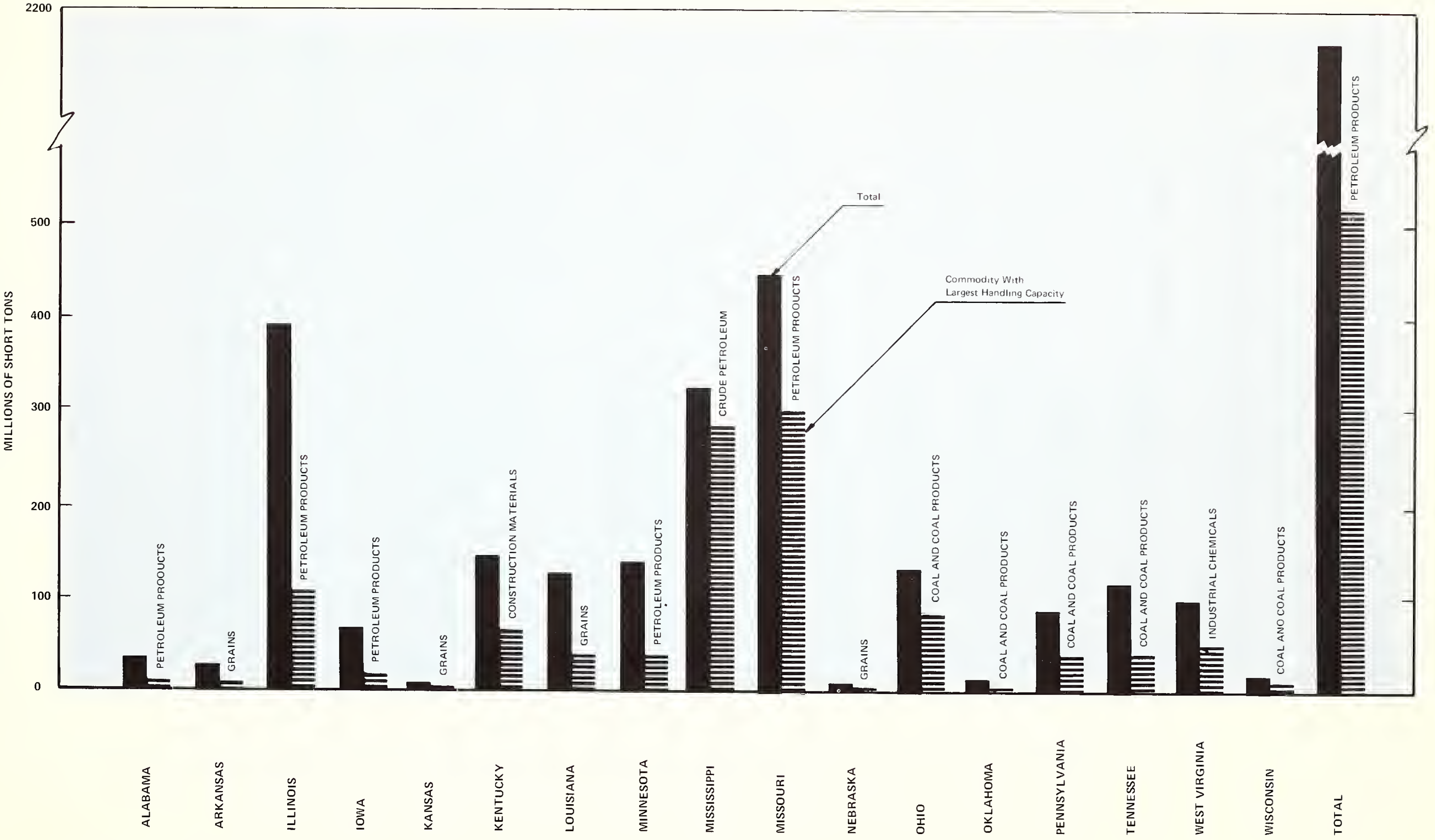
Industrial Chemicals

Industrial chemical facilities have almost 310 million short tons of handling capacity, principally of a liquid bulk nature. Major states include Illinois, Missouri and West Virginia.

Other Commodity Groups

In descending order of cargo handling capacity for the entire study area are:

- Construction materials, mining products, waste and scrap materials and waterway improvement and government materials (250 million short tons);
- Agricultural chemicals and fertilizers (87 million short tons);
- Primary metal products (45 million short tons);
- Iron and other ores (except aluminum) (29 million short tons);
- Sugar and molasses (23 million short tons);
- General cargo, N.E.C. (12 million short tons);
- Scrap metals (8 million short tons);
- Lumber products (7 million short tons);
- Bauxite and aluminum ores (4 million short tons);
- LPG (3 million short tons).



TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 31 ESTIMATED ANNUAL CARGO HANDLING CAPACITY

CHAPTERS 16 TO 19
REQUIREMENTS PHASE

CHAPTER 16

FORECAST WATERBORNE COMMERCE DEMAND VS. HANDLING CAPACITY

This chapter presents a comparison of forecast waterborne commerce demand with estimated cargo handling capacity. The comparison is performed by commodity group at the subregion, and provides the basis for the planning of future facility requirements.

The annual handling capacity estimates presented in Chapter 15 are compared herein with the forecast annual commodity volumes presented in Chapter 14, for each of the forecast design years, to arrive at an estimate of future handling capacity deficits or excesses.* A deficit indicates that future demand will exceed available capacity. To accommodate this future demand, additional cargo handling capacity must be provided in the form of new or upgraded facilities. The translation of cargo handling deficits (measured in short tons) into facility needs and costs is described in the subsequent chapters, while this chapter summarizes the magnitude of potential facility needs.

Estimated cargo handling capacity is compared to the mid-range commodity forecast.

METHODOLOGY

The estimate of annual cargo handling capacity presented in Chapter 15 is based upon the information contained in the facility inventory. With the exception of selected "checks" and compensating adjustments performed in the computation of apron and storage capacities, the study methodology relies entirely upon the inventory data to provide an accurate description of existing facilities. Missing data elements for inventoried facilities (a common omission is failure to distinguish between loading and discharging handling rates, even when the terminal has both capabilities) cannot be remedied and must be interpreted at face value. In similar fashion, it is not possible to estimate a handling capacity if the facility is not in the inventory.

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* The estimates presented in Chapters 14 and 15 are summarized at the state level of aggregation. The analyses, however, are performed at the subregional level and are presented in Appendix J, which is compiled separately by state.

The net impact of the data omissions and incomplete facility inventory is to understate existing cargo handling capacity. This is apparent when, in this phase of the analysis, the estimated capacities (i.e. Table 15-3) are compared to the 1976 commodity flows at the subregion level by commodity group. In many instances, the commodity demand exceeds the handling capacity by an amount which is significantly greater than one might attribute to normal estimating errors.* Estimating errors may be introduced by the capacity calculation estimates and variations in cargo handling techniques within the waterborne commodity groups. Moreover, selected commodity movements are never handled over terminal facilities even though they appear in the U.S. Army Corps of Engineers Waterborne Commodity Statistics; of particular concern in this regard are waterway improvements materials, construction materials and even some grains in Louisiana which are transshipped directly from barge to ocean-going vessel by floating cargo handling equipment.

In recognition of the above, it was necessary to make a compensating adjustment to carry out the demand-capacity analysis and provide a reasonable basis for estimating facility needs and costs; it would be applied only in those instances in which the 1976 commodity demand exceeds estimated capacity. Several such adjustments were considered. It was decided that a reasonable approach entailed increasing "deficient" capacities so that they would equal existing commodity demand. For example, if estimated handling capacity within a subregion for a commodity group is 1.0 million short tons and the volume actually handled in 1976 was 1.2 million short tons, the capacity would be adjusted upwards to the 1.2 million figure. If there is growth in the commodity, then a capacity deficit would be indicated in 1980 in the demand-capacity analysis.

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* The instances where this occurs are indicated on computer printouts in Appendix J.

As noted earlier, the demand/capacity analyses are performed at the subregional level of detail and the capacity within a commodity group is assumed interchangeable at this level. Capacities between subregions are assumed not to be interchangeable. Statistics are summarized in this chapter at the state level.

One further note. A direct comparison with the summary traffic tables shown in Chapter 14 is misleading, inasmuch as they exclude, for reasons of statistical consistency, one-half of the intrastate traffic movements; in other words, the Chapter 14 tables understate the magnitude of cargo which moves through the study area's terminal -- an intrastate movement is handled twice within a state, once at the loading end and again at the unloading terminal. In 1976 this volume totalled 145 million short tons and in the year 2000 it is forecast to increase to 278 million short tons, all of which must be accommodated by terminal handling facilities.

ESTIMATED CARGO HANDLING DEFICITS

The primary indicator of future facility needs and the basis for subsequent terminal planning is the estimate of cargo handling deficit; a deficit is generated when future commodity demand exceeds available handling capacity.

Table 16-1 summarizes the estimated annual cargo handling deficits for all commodities by state and by year for the study area. In the year 1980 a total of 117 million short tons loading and unloading capacity will be required in the study area. On the loading side, Illinois has the largest deficit, 65 percent of which is in coal. For unloading, Louisiana accounts for about 50 percent of the total unloading deficit, 34 percent of which is in grains. By the year 1990, the study area's deficit in handling capacity will triple, reading 351 million short tons, split almost equally between loading and unloading.

In the year 2000, the total deficit is estimated at 692 million short tons. On the loading side Louisiana has the largest deficit and accounts for 23 percent of the year 2000 handling deficit, 41 percent of which is in crude petroleum; for unloading, Louisiana also stands out, accounting for 43 percent of the total year 2000 unloading needs, of which 34 percent is in grains.

By way of comparison, between 1976 and 2000 there will be a 780 million ton increase in study area traffic to be handled by port terminals. To accommodate this additional traffic, 692 million tons of new handling capacity must be provided, or 89 Percent of the projected growth; the remaining 11 percent will come from existing capacity.

Table 16-2 summarizes existing annual handling deficit by commodity group and by year.

Coal and coal products is the commodity group with the largest cargo handling deficit. Beginning in 1980, coal loading and unloading accounts for about 50 percent of the 17-state cargo handling deficit of 127 million short tons; by 2000 the coal deficit grows to 239 million short, which is 35 percent of the total study area short-fall in this year.

The deficit in petroleum products increases ten-fold from 1980 to the year 2000, so that by the end of the forecast

TABLE 16-1

CUMULATIVE ANNUAL CARGO HANDLING CAPACITY DEFICITS ALL COMMODITIES, BY STATE

(000's short tons)

State	Loading					Unloading				
	1980	1985	1990	2000	Major Deficit Commodities[1] (% total)	1980	1985	1990	2000	Major Deficit Commodities[1] (% total)
Alabama	8,625	20,174	36,306	70,783	Crude Petro.(32) Coal(18) Const. Mat'ls. (16)	6,913	19,605	30,501	47,043	Coal(38) Ores(21) Const. Mat'ls. (17)
Arkansas	1,273	2,552	4,099	8,930	Waterway Improvm't (57) Grains (26) Petro. Prods. (11)	3,170	9,507	14,969	28,755	Petro. Prods. (45) Coal (32) Const. Mat'ls. (17)
Illinois	22,927	43,333	45,581	56,204	Coal (65) Grains (22) Petro. Prods. (6)	6,418	6,507	6,709	11,455	Coal (52) Agri. Chem. (19) Const. Mat'ls. (13)
Iowa	747	951	1,119	3,453	Grains (99)	82	89	171	719	Agri. Chem. (43) Sugar/Mol. (30) Coal (15)
Kansas	0	38	0	0	--	0	0	0	0	--
Kentucky	7,426	6,258	7,729	13,167	Waterway Improvement(46) Coal (41) Grains (7)	1,521	4,092	6,648	16,037	Petro. Prods. (47) Coal (42) Chem. Prods. (8)
Louisiana	7,617	16,856	29,755	79,289	Petro. Prods. (41) Agri. Chem. (16) Ind. Chem. (14)	24,550	45,637	69,278	147,824	Grains (34) Agri. Chem. (25) Petro. Prods. (14)
Minnesota	0	0	0	6,717	Coal (70) Grains (30)	895	1,217	1,397	2,169	Coal (100)
Mississippi	576	1,256	3,548	11,369	Petro. Prods. (31) Waterway Improvement(21) Grains (19)	1,352	10,074	16,329	30,466	Coal (44) Petro. Prods. (28) Agri. Chem. (15)
Missouri	9,881	19,155	26,887	42,190	Coal (76) Waterway Improvement(10) Grains (9)	1,878	2,113	2,569	5,464	Agri. Chem. (33) Coal (31) Petro. Prods. (19)
Nebraska	0	1	2	6	--	8	12	15	248	Const. Mat'ls. (95)
Ohio	465	4,314	9,838	30,703	Coal (93) Waterway Improvement(3)	495	2,948	5,680	19,321	Coal (95) Agri. Chem. (4)
Oklahoma	1,139	2,738	3,651	5,024	Grains (100)	0	0	5	141	Agri. Chem. (83)
Pennsylvania	847	2,396	3,916	8,793	Coal (96)	1,233	2,301	3,459	8,266	Coal (86) Petro. Prods. (12)
Tennessee	1,316	6,952	8,183	11,268	Grains (33) Coal (27) Petro. Prods. (18)	2,480	4,436	5,910	11,696	Const. Mat'ls. (53) Coal (22) Ind.Chem. (14)
West Virginia	2,441	1,569	1,308	2,618	Petro. Prods. (56) Waterway Improvement(29)	784	4,108	4,744	10,202	Coal (72) Const. Mat'ls. (23)
Wisconsin	166	212	221	444	Grains (96)	6	305	970	1,274	Coal (98)
TOTALS	65,446	128,755	182,143	350,958		51,785	112,951	169,354	341,080	

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[1] % Computed for year 2000 deficit.

TABLE 16-2

FORECAST ANNUAL CARGO HANDLING DEFICITS, BY COMMODITY GROUP

(000's of short tons)

Commodity Group	Loading				Unloading			
	1980	1985	1990	2000	1980	1985	1990	2000
Grains	8,633	15,502	21,206	38,218	12,190	21,041	29,054	50,381
Iron Ores	119	1,949	6,575	11,187	493	2,037	6,530	10,955
Baux. Ores	185	125	89	46	23	27	31	45
Coal	39,671	76,599	89,396	132,197	23,415	55,812	67,012	106,635
Crude Oil	3,118	6,578	10,555	23,585	285	283	662	3,631
Petro.Prod.	4,550	11,356	18,742	46,087	4,983	12,789	23,415	57,213
Chem.Prod.	2,102	2,780	3,996	14,265	2,108	5,021	8,310	19,572
Fertilizers	908	1,451	3,501	14,711	2,356	7,024	14,785	48,899
Manuf.Prod.	451	2,103	4,060	9,622	-	-	-	-
Lumber Prod.	626	1,672	3,429	15,251	-	-	-	-
Sugar/Mol.	30	40	105	863	104	118	192	505
Prmy.Mtl.Prod.	258	1,113	2,770	4,061	-	-	-	-
Scrap Metals	77	89	410	1,127	-	-	-	-
Constr.Matls.	4,725	7,398	17,309	39,738	5,828	8,862	19,363	43,246
LPG	-	-	-	-	-	-	-	-
TOTALS	65,453	128,755	182,143	350,958	51,785	113,014	169,354	341,082

period it has the second largest study area deficit, 101 million short tons.

By the year 2000, cash and milled grains will have a cumulative total study area deficit of 88 million short tons, loading and unloading, or 13 percent of the total. The three commodity groups with the largest deficits -- coal, petroleum products, and grains -- account for 62 percent of the loading and unloading shortfall in the year 2000.

Waterway improvement and construction materials have a cumulative deficit of 83 million short tons by the year 2000; however, given the method of material handling associated with this commodity group, it is highly doubtful that this deficit translates, in total, to facility needs.

The next two chapters describe the methodology employed in translating these cargo handling deficits into facility needs and development costs.

Figure 32 graphically displays study area cargo handling deficits.

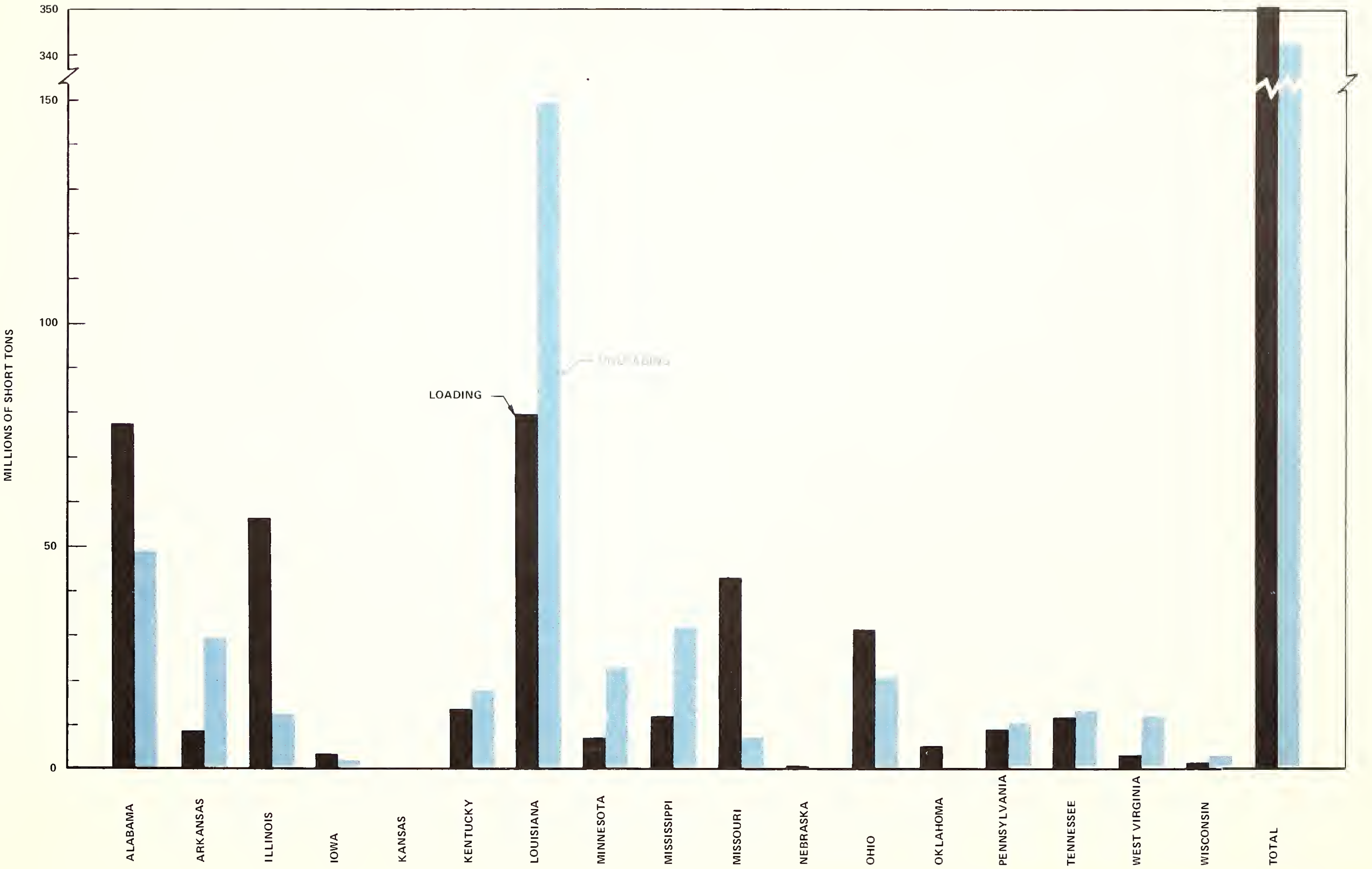

FIGURE 32 CUMULATIVE CARGO HANDLING DEFICITS (1980-2000)

CHAPTER 17

TERMINAL PLANNING CONCEPTS AND COSTS

This chapter describes the planning process utilized in the development of conceptual barge terminal plans which were used to establish land requirement and cost data inputs to the Cost Allocation Model. The Cost Allocation Model translates cargo handling deficits into costs and is described in Chapter 18; it is discussed here only to illustrate the relationship of this chapter to the study as a whole.

The following were established for various terminal facility types:

- annual cargo handling and storage capacity C_B;
- cost to upgrade apron capacity by an amount C_B;
- cost to upgrade storage capacity by an amount C_B;
- cost to construct a new facility of capacity C_B;
- land area required for such new facility.

The factors were converted to a per-ton basis in the Cost Allocation Model by dividing each of the last four factors listed above by the annual cargo throughput, C_B. These per-ton figures and were then applied to the projected cargo handling and storage capacity deficits to yield the estimated costs and land needs for terminal facilities in the forecast period.

Thirteen categories of terminal facilities were established in deriving the cost and land area factors (Table 17-1). Within each category are alternative facility types corresponding to variations in terminal size, location in the study region, and direction of cargo transfer (whether loading or unloading). For each facility type, a site plan was generated for a conceptual terminal which is posited as representative of new construction on the waterways within the forecast period. Of course, each river terminal built or expanded in the future will differ in many ways from the conceptual terminal; thus the characterization of all future construction of a given

TABLE 17-1

TERMINAL FACILITY CATEGORIES USED IN PREPARING COST ESTIMATES

Facility Type	Corresponding Commodity Groups
Grain	1 - Cash Grains 9 - Milled Grain and Agricultural Products, NEC
Ores	2 - Iron and Nonferrous Metal Ores and Concentrates 3 - Bauxite and Other Aluminum Ores and Concentrates
Coal	4 - Coal and Coal Products
Crude Petroleum	5 - Crude Petroleum
Petroleum Products and Lubricants	6 - Petroleum Products and Lubricants
Industrial Chemicals	7 - Industrial Chemicals
Fertilizer	8 - Agricultural Chemicals/Fertilizers
Break-Bulk	13 - Fabricated Metal Products 17 - Non-Durable Manufactures NEC, including Processed Foods 18 - Durable Manufactures, NEC
Lumber & Wood Products	10 - Lumber & Wood Products
Sugar & Molasses	11 - Sugar & Molasses
Primary Metal Products	12 - Primary Ferrous & Nonferrous Metal Products
Scrap Metal	14 - Scrap Metals
Construction Materials	15 - Construction Materials 16 - Mining Products, NEC 19 - Waste and Scrap Materials, NEC 20 - Waterway Improvement and Government Materials

facility type by one conceptual terminal is a generalization, albeit a necessary one. In this light it should be borne in mind that the costs and land requirements presented are order-of-magnitude estimates, and that actual requirements may deviate from the projections because of conditions peculiar to each subregion. To aid in evaluating the extent to which actual conditions vary from those assumed in laying out the conceptual terminals, the assumed conditions are outlined later in this chapter.

Another qualification regarding the cost factors should be noted: the costs of land acquisition and financing were excluded from the estimates. These items, too, will vary with the unique circumstances or each subregion, and with changing economic conditions over the forecast period.

SCOPE OF CONCEPTUAL TERMINALS

Each conceptual terminal is dedicated to one cargo transfer operation -- e.g., loading grain. The terminal can service just one barge at a time and only one berth is provided. Annual cargo transfer capacity of this berth is in balance with that of the terminal's storage facilities; that is, the storage capacity equals the demand for storage when the berth operates at 100 percent of practical capacity.

No attempt was made to determine fleeting area requirements, as these are largely dependent on operating practices.

Cost estimates derived from the conceptual terminals contain only those components related directly to waterborne commerce. Consider, for example, the conceptual coal unloading facility in Figure 36a.* Coal is unloaded from barges and conveyed to open storage piles, from which it is later reclaimed and conveyed to a surge pile, and ultimately to a plant. The plant may be a power generating facility which receives coal by rail as well as by barge. In this case, one large storage area would be furnished for both waterborne coal and coal received by rail. However, the Mid-America Ports Study is not concerned with the costs of providing storage for coal which moves only by rail, so the conceptual terminal layout contains storage space only for waterborne coal. For the same reason, no railroad trackage was included in the conceptual coal unloading facility.

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* Figures 35 and 36 follow page 246.

On the other hand, the surge pile is treated as part of the conceptual terminal. One could make a case for not including the surge pile because it is part of the inland access mode (in this case a conveyor system from storage pile to power plant) and is independent of barge unloading operations. Nevertheless any future coal unloading terminal will have to provide an area for transfer from storage pile to inland access mode. Thus the inland access mode consumes space at the barge terminal although it is not part of the barge unloading system. Furthermore, the inland access mode has three components -- an inland terminal (at the power plant), line haul segment (the conveyor itself), and a waterside terminal, of which only the latter is located at the barge facility. Consequently, the Mid-America estimates of barge facility requirements included the area and site preparation costs of land required by the inland access mode's waterside terminal, but ignored the line haul and inland terminal components. All equipment for the inland access mode, including that at the waterside terminal, was excluded from the estimated costs as it is extraneous to the barge unloading system. This is illustrated in the coal unloading example, in which the inland conveyor system's waterside terminal consists of a surge pile and belt loading apparatus. The land occupied by the surge pile and loading apparatus was counted as part of the conceptual barge terminal's site area, but the cost of the loading apparatus was neglected.

The criteria for inclusion of inland access mode elements in the conceptual terminal were applied to all facilities: consider, for example, a loading terminal (Figure 36b) where coal from a mine arrives by rail. The inland access mode in this case is railroad rather than conveyor, and the corollaries to power plant, conveyor and surge pile are, respectively, the mine, railroad mainline, and railroad car dumper with associated trackage and equipment, such as the car thawer and stockout apparatus. The car dumper and associated equipment were not included in estimating capital costs. However, the land they occupy was considered part of the terminal, as was the land needed for trackage. Construction of rail sidings and loops (but not for the mainline) is an element of site preparation, and contributed to the site preparation cost.

One further distinction was made in delimiting the conceptual terminals. Facilities for oceangoing vessels were not considered part of the terminals; only inland waterway components were included. Thus the conceptual terminal for ore loading in the southern superregions (Figure 35e) contains the ore storage and barge loading elements of a hypothetical ship-to-barge transfer facility; the ship unloading element was excluded.

DEVELOPMENT OF CONCEPTUAL TERMINALS

The estimation of conceptual terminal costs and land requirements required two bodies of information: physical characteristics of each terminal, and unit costs for cargo handling equipment, wharf structures, and site preparation.

Physical characteristics of the storage portion of each terminal were derived by applying the apron and storage capacity equations of Chapter 15 to selected handling rates, assuming a balance between apron and storage capacities ($C_B = C_S$). This yielded a required amount of instantaneous storage capacity which directly determined such physical parameters as number of storage tanks and dimensions of storage piles.

Physical characteristics of the apron portion of the terminal, i.e., the wharf, were dictated by the type of handling equipment chosen.

With the nature of these components established, it became possible to sketch a site plan for each conceptual terminal. This was done making certain assumptions about site conditions and access, which are discussed below. The conceptual terminal site plan provided the basis for an order-of-magnitude estimate of the development cost of a new barge terminal.

Certain portions of the conceptual terminal were identified as elements that would require development if an existing terminal were to be upgraded to increase its storage capacity -- added shed space, for example. Likewise, certain elements were identified as components of an apron capacity upgrading. The costs of upgrading were then extracted from the estimated costs of a new facility.

Land area requirements were taken directly from the conceptual terminal site plan.

The conceptual terminal development/land area and cost estimation procedure just described is depicted by the flow chart, Figure 33. Several aspects of the general procedure are dealt with in the next few sections, followed by some notes on conceptual terminals for specific facility types. Finally, several summary tables complete the chapter and allow comparison of certain assumed characteristics, estimated costs, and land requirements of the conceptual terminals.

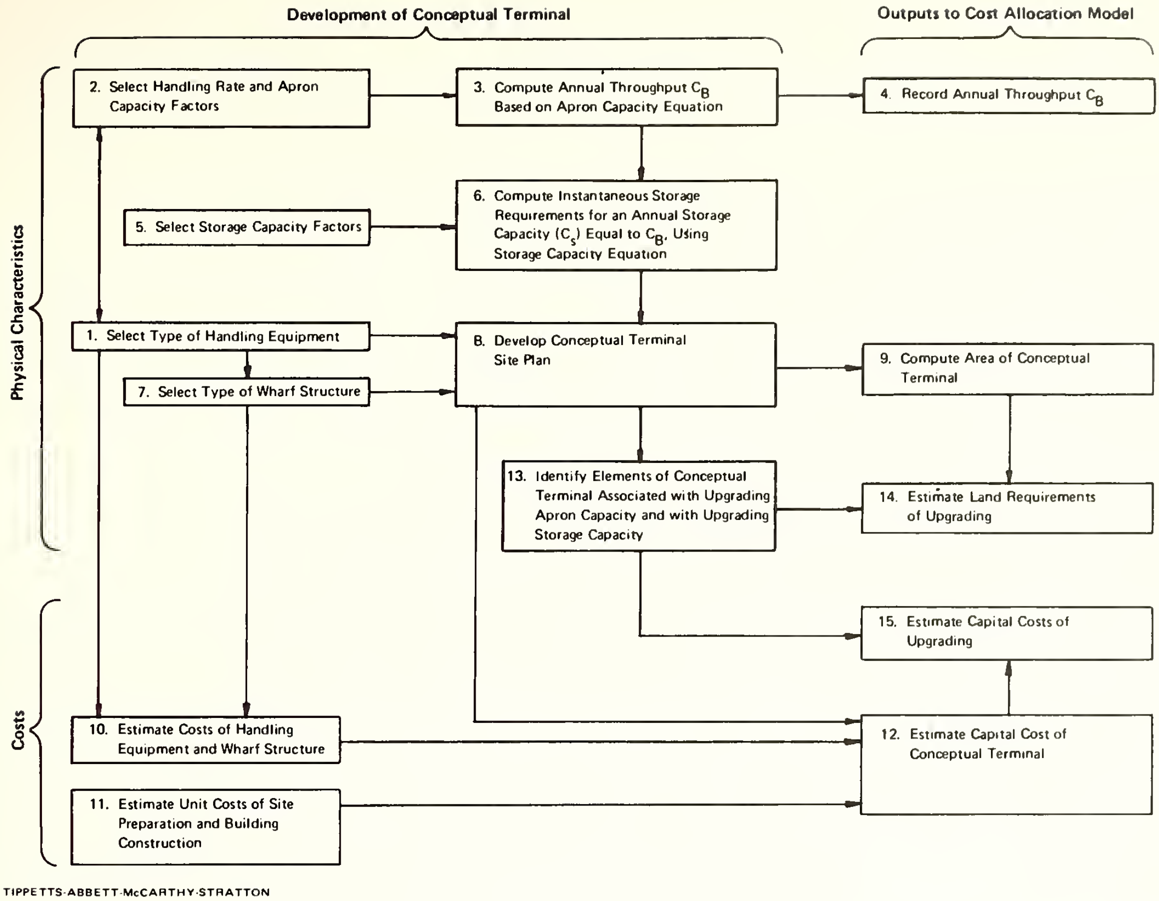
Development of Conceptual Terminal
Outputs to Cost Allocation Model
Physical Characteristics
Costs
2. Select Handling Rate and Apron Capacity Factors
3. Compute Annual Throughput C_B Based on Apron Capacity Equation
4. Record Annual Throughput C_B
5. Select Storage Capacity Factors
6. Compute Instantaneous Storage Requirements for an Annual Storage Capacity (C_s) Equal to C_B, Using Storage Capacity Equation
1. Select Type of Handling Equipment
7. Select Type of Wharf Structure
8. Develop Conceptual Terminal Site Plan
9. Compute Area of Conceptual Terminal
13. Identify Elements of Conceptual Terminal Associated with Upgrading Apron Capacity and with Upgrading Storage Capacity
14. Estimate Land Requirements of Upgrading
15. Estimate Capital Costs of Upgrading
10. Estimate Costs of Handling Equipment and Wharf Structure
12. Estimate Capital Cost of Conceptual Terminal
11. Estimate Unit Costs of Site Preparation and Building Construction

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FIGURE 33 - PROCEDURE FOR ESTIMATING COSTS AND LAND AREAS

Handling Rates and Capacity Factors

As previously noted, conceptual terminal storage facility requirements were derived from assumed handling rates and the capacity equations of Chapter 15 . The handling rates were chosen to reflect anticipated improvements in equipment and operations, as discussed in Chapter 11 , and are summarized here in Table 17-2 . The same capacity factors were used for conceptual terminal development as were used in the capacity analysis model (Table 15-20).

TABLE 17-2

CONCEPTUAL TERMINAL COMMODITY HANDLING RATES

	Design Handling Rate H (stph)	
	Load	Unload
Grain - Small	700	400
Large	2000	2000
Ores		
Bauxite	5000	3000
Coal - Small	500	4000
Large	5000	4000
Crude Petroleum and Petroleum Products[1] - Small	125	125
Large	250	250
Industrial Chemicals[1] - Small	210	210
Large	420	420
Fertilizer	2000	1000
Break-Bulk	25	25
Lumber Wood Products	100	100
Sugar	-	400
Molasses	56[2]	56[2]
Metal Products	75	75
Scrap Metal	60	60
Non-Metallic Minerals	600	400

---

[1] Handling rates correspond to 600 gpm (small) and 1200 gpm (large).

[2] Assuming a density of 52 pcf at which 1 bbl = 0.14 st.

Inasmuch as some capacity factors vary by superregion and since both high and low handling rates were used for certain cargo types, there are many more facility types than there are cargo types. Both handling rates and capacity factors can vary by direction of cargo transfer as well, necessitating a distinction between conceptual loading terminals and conceptual unloading terminals. For general cargo terminals, however, no distinction was made between loading and unloading, since both operations occur at typical general cargo installations, and since all general cargo handling was treated as a loading operation in other portions of the study.

Wharf Structures

Five types of wharf structures were used in the conceptual terminals (Figure 34). Wharf structures A and C correspond to the use of fixed bulk loaders or unloaders. Type B is used with traveling cranes for bulk cargoes. All three consist of a platform linked to shore by a trestle; type A also includes two breasting dolphins.

Wharf Structure D represents a general cargo wharf consisting essentially of landfill retained by sheet piling and capped with concrete. Wharf Structure E consists of two sunken barges, filled with sand and capped with concrete.

The estimated costs of wharf structures are given in Table 17-3. rounded to the nearest $100,000. All were based on a river stage of 30 ft. Although actual wharf costs increase in proportion to the range of river level fluctuations,this variation is insignificant in comparison to other cost elements (site preparation, equipment) of the conceptual terminals, and was neglected.

Dredging costs were based on deepening each berth by 5 feet under an area of dimensions 250 feet by 200 feet. Two mooring dolphins were included in each cost estimate to provide for fleeting.

TABLE 17-3
ESTIMATED COSTS OF WHARF STRUCTURES

Wharf Type	Corresponding Cargo Types	Estimated Cost ($)
A	Bulks	500,000
B	Bulks	800,000
C	Bulks	700,000
D	General Cargo	1,500,000
E	Construction Materials	100,000

Storage Area Costs

Storage area costs were based on the figures in Table 17-4. Costs of storage equipment such as conveyors and stacker/reclaimers were estimated separately, as were the costs of grain silos and liquid bulk storage tanks.

It was assumed that utilities and a public road adjoin the terminal property. The site, moreover, would require modest grading, and a distance of 60 feet was assumed from the riverbank to the 9 ft. deep contour of the channel.

Rail connections were assumed for: break-bulk, lumber and wood products, and primary metals terminals; loading terminals for coal, ore (superregions 1 and 2), fertilizer, and grain; unloading terminals for grain and raw bulk sugar. 1/ A rail mainline was assumed to run along the property line parallel to the river. Ore and coal terminals with rail access provide loops or wyes for turning trains around.

1/ Bulk sugar unloading terminals were used to develop costs for the Sugar and Molasses facility types.

TABLE 17-4

UNIT COSTS FOR CONCEPTUAL TERMINAL STORAGE AREAS

Item	Unit Cost
General Site Preparation[1]	$40,000/acre
Lighting	$10,000/acre
Fencing	$10/LF
Roads[2]	$30/LF
Paving	$80,000/acre
Railroads[3]	$125/LF
Buildings[4]	$25/SF
Utilities, engineering, miscellaneous costs and contingency	25% of total

---

[1] Includes clearing, grading, drainage, fill, compaction.

[2] 12 ft. wide, 3" bituminous pavement.

[3] Single track. Includes ballast, ties and rail.

[4] $35/SF for fertilizer storage sheds.

Upgrading Costs

Upgrading refers to the improvement of an existing terminal for the purpose of increasing capacity. Two types of upgrading were considered:

- upgrading to increase apron (berth) capacity;
- upgrading to increase storage capacity.

These are termed "apron upgrading" and "storage upgrading", respectively. Cost estimates were produced for annual capacity increases equal to the annual capacity (C_B) for which each conceptual terminal was designed.

It was recognized that certain economies (per ton of cargo moved) may be realized in expanding an existing facility as opposed to building a new one. Accordingly, some components of the conceptual terminal costs were reduced or omitted in computing the upgrading costs. Table 17-5 identifies those components which were included in the upgrading estimates.

It should be noted that stacker/reclaimer equipment was omitted from the upgrading costs for solid bulk terminals. Existing stacker/reclaimers were assumed to be adequate for handling upgraded terminal capacities.

Land requirements were reduced in the same proportion as site costs and were assumed to accompany storage upgrading but not apron upgrading.

CHARACTERISTICS OF CONCEPTUAL TERMINALS

The facilities shown in Figures 35, 36 and 37 are representative of the conceptual terminals used for estimating costs and land requirements. Characteristics of the conceptual terminals' apron equipment and wharf structures are summarized in Table 17-6; storage characteristics are given in Table 17-7. Table 17-8 lists the costs, land requirements, and annual throughput of each conceptual terminal. Also shown in Table 17-8 are figures for instantaneous storage capacity, which is defined as the amount of cargo a storage area can hold at one time.

Several clarifications should be made concerning the information presented in Tables 17-6, 7, 8. These are grouped here by facility type.

Grains (Figures 35a, b) - Conceptual grain unloading terminals (Figure 35b) are export facilities where grain is transferred from barges to storage, thence to oceangoing vessels. As discussed earlier, the oceangoing portions of such facilities are excluded from the cost and land estimates.

Grain silos are 140 ft. high and 30 ft. in diameter. The circular tanks shown are 40 ft. high and 90 ft. in diameter. Foundation costs for such heavy structures as grain elevators can be substantial if piling is required. Since soil conditions vary from site to site, it was assumed that half of the elevator in each terminal has a pile foundation, representing an "average condition".

TABLE 17-5

CONCEPTUAL TERMINAL COMPONENTS INCLUDED IN ESTIMATES OF UPGRADING COSTS

Facility Type	Apron Upgrading	Storage Upgrading
Grain	Wharf Loading/Unloading Equipment Conveyor between apron and workhouse	Silos, tanks & workhouse equipment 0.5 (site costs)
Solid Bulk[1]	Wharf Loading/Unloading Equipment Conveyor	0.9 (site costs)
Liquid Bulk[2]	Wharf Pumps and Related Equipment Piping between wharf and nearest tank	Tanks, dikes, and piping beyond first tank 1.0 (site costs)
General Cargo[3] & Construction Materials	Wharf Loading/Unloading Equipment	0.9 (site costs)

---

[1] Includes Ores, Coal, and Fertilizers

[2] Includes Crude Petroleum, Petroleum Products, Industrial Chemicals, and Molasses

[3] Includes Break-Bulk, Lumber & Wood Products, Sugar, Primary Metal Products, Scrap Metal

TABLE 17-6

APRON CHARACTERISTICS OF CONCEPTUAL TERMINALS

Facility Type	Handling Rate[1]	Handling Equipment	Wharf Structure[2]
Grain loading, Small	700 tph (24,500 bu/hr)	Chutes; spouts	A
Grain unloading, small	400 tph (14,000 bu/hr)	Pneumatic unloaders; mechanical marine legs; grab buckets	A
Grain loading, large	2,000 tph (70,000 bu/hr)	Spouts	C
Grain unloading, large	2,000 tph (70,000 bu/hr)	Continuous bucket elevator unloader	C [3]
Ore loading	5,000 tph [4]	Traveling boom belt loader, stacker/reclaimer	B
Ore unloading	3,000 tph [4]	Two traveling grab bucket unloaders, stacker/reclaimer	B
Coal loading, small	500 tph	Car dumpers; chutes; shovels; moderate size conveyors	A
Coal unloading, small	400 tph	Grab bucket	A
Coal loading, large	5,000 tph [4]	Stationary conveyor boom loader	A [5]
Coal unloading, large	4,000 tph [4]	Bucket elevator unloader	A [5]
Liquid Bulk loading, small [6]	600 gpm	Pump on shore	A
Liquid Bulk unloading, small [6]	600 gpm	Pump on barge	A
Liquid Bulk loading, large [6]	1,200 gpm	Pump on shore	A
Liquid Bulk unloading, large [6]	1,200 gpm	Pump on barge	A
Fertilizer loading	2,000 tph [4]	Stationary conveyor boom loader	A
Fertilizer unloading	1,000 tph [4]	Two traveling grab bucket unloaders, stacker/reclaimers	B
Break-Bulk	25 tph	Crane	D
Lumber & Wood Products	100 tph	Crane	D
Sugar & Molasses [7]			
Molasses loading	400 bbl/hr	Pump on shore	A
Sugar unloading	400 tph	Grab bucket	D
Molasses unloading	400 bbl/hr	Pump on barge	A
Primary Metal Products	75 tph	Crane	D
Scrap Metal	60 tph	Crane	D
Construction Material loading	600 tph	Chute or crane	E
Construction Material unloading	400 tph	Crane	E

---

[1] tph refers to short tons per hour.

[2] Refer to Table 17-3 for identification of wharf types.

[3] Estimated costs of roofed unloading shed and barge positioning winches were included in handling equipment costs.

[4] Stacker/reclaimers have lower handling rates.

[5] Estimated cost of rope haul positioner included in handling equipment costs.

[6] Comprises Crude Petroleum, Petroleum Products & Lubricants, and Industrial Chemicals.

[7] The conceptual terminals for Sugar & Molasses are hybrids of terminals developed separately for each commodity. Refer to text.

TABLE 17-7

STORAGE CHARACTERISTICS OF CONCEPTUAL TERMINALS

Facility Type	Storage Method	Storage Equipment	Percent Closed Storage[1]
Grain	Silos, tanks	Conveyors, elevators, weighing equipment	100
Ore	Open stockpile	Stacker/reclaimer and conveyor system	0
Coal	Open Stockpile	Stacker/reclaimer and conveyor system	0
Liquid Bulk[2]	Tanks	Piping and related equipment	100
Fertilizer	Shed, open stockpile	Stacker/reclaimer and conveyor system	75
Break-Bulk	Shed	[3]	100
Lumber and Wood Products	Shed, open yard	[3]	50
Sugar and Molasses[4]	Shed, tanks	[4]	100
Primary Metal Products	Shed, open yard	[3]	50
Scrap Metal	Open Pile	[3]	0
Construction Materials	Open stockpile	[3]	0

---

[1] Percent of stored cargo tonnage which is stored in sheds, silos or tanks.

[2] Comprises crude petroleum, petroleum products and lubricants and industrial chemicals.

[3] Mobile equipment such as forklifts and front end loaders would be used at these facilities, often in conjunction with the same crane used for loading and unloading barges. Storage equipment costs were not included in the cost estimates for these facilities.

[4] The conceptual terminals for Sugar and Molasses are hybrids of terminals developed separately for each commodity. Refer to text.

TABLE 17-8

ESTIMATED COSTS AND LAND REQUIREMENTS OF CONCEPTUAL TERMINALS

	Facility Type			Annual Throughput C_B (000 st)	Instantaneous Storage Capacity[1] (000 st)	Total Area (Acres)	Apron Upgrading Cost[2] ($ million)	Storage Upgrading Cost[2] ($ million)	New Facility Cost[2] [3] ($ million)
	Small (S) or Large (L)	Load (L) or Unload (U)	Super - Regions						
Grain	S	L	1,2	598	34	4.8	1.6	12.7	14.6
	S	L	3,4	997	19	3.8	1.1	7.2	8.7
	S	U	1,2	281	23	4.1	1.8	8.4	10.4
	S	U	3,4	469	12	3.2	1.8	4.4	6.4
	L	L	1,2	1,709	98	6.9	3.8	35.8	40.1
	L	L	3,4	2,848	55	5.5	2.4	20.2	23.0
	L	U	1,2	1,407	116	9.0	4.5	37.6	47.6
	L	U	3,4	2,345	58	6.9	4.5	21.3	26.2
Ores	-	L	1,2	12,814	995	39.5	4.2	6.1	15.5
	-	L	3,4	12,814	663	20.0	4.2	3.3	11.2
	-	U	1,2	6,332	1,145	32.1	6.5	3.6	14.7
	-	U	3,4	6,332	492	17.2	6.5	2.6	13.1
Coal	S	L	1,2	712	16	11.3	1.1	2.1	4.1
	S	L	3,4	712	66	19.2	1.1	2.1	4.2
	S	U	1,2	469	131	12.4	1.3	1.8	4.2
	S	U	3,4	469	44	6.7	1.3	1.1	3.6
	L	L	1,2	7,119	161	36.5	3.1	6.0	12.8
	L	L	3,4	7,119	663	67.6	3.1	7.7	14.6
	L	U	1,2	4,690	1,311	76.7	4.4	8.0	16.4
	L	U	3,4	4,690	437	30.4	4.4	4.0	12.0
Crude Petroleum	S	L	all	339	23	6.1	1.0	3.2	4.2
	S	U	1,2	339	82	16.9	0.9	9.3	10.2
	S	U	3,4	339	71	14.6	0.9	7.9	8.8
	L	L	all	678	47	11.4	1.0	6.3	7.3
	L	U	1,2	678	165	33.7	0.9	19.0	19.9
	L	U	3,4	678	141	29.3	0.9	15.7	16.6
Petroleum Products	S	L	all	339	23	7.5	1.0	5.0	6.0
	S	U	1,2	339	82	18.7	0.9	16.2	17.1
	S	U	3,4	339	71	16.4	0.9	14.0	14.9
	L	L	all	678	47	12.0	1.0	10.1	11.1
	L	U	1,2	678	165	34.7	0.9	32.5	33.4
	L	U	3,4	678	141	30.5	0.9	28.0	28.9
Industrial Chemicals	S	L	all	570	39	7.5	1.0	5.0	6.0
	S	U	1,2	570	138	18.7	0.9	16.2	17.1
	S	U	3,4	570	119	16.4	0.9	14.0	14.9
	L	L	all	1,139	79	12.0	1.0	10.1	11.1
	L	U	1,2	1,139	277	34.7	0.9	32.5	33.4
	L	U	3,4	1,139	237	30.5	0.9	28.0	28.9
Fertilizer	-	L	1,2	5,126	398	41.5	2.1	38.6	48.5
	-	L	3,4	5,126	265	28.4	2.1	23.3	33.3
	-	U	1,2	2,111	765	31.8	4.0	32.2	42.2
	-	U	3,4	2,111	328	15.1	4.0	13.8	23.0
Break-Bulk	-	-	1,4	53	2	2.4	1.7	0.8	2.6
	-	-	2	53	4	3.0	1.7	1.3	3.2
	-	-	3	53	2	1.8	1.7	0.6	2.4
Lumber & Wood Products	-	-	1,4	212	8	2.2	1.7	1.2	3.0
	-	-	2	212	17	4.7	1.7	2.5	4.5
	-	-	3	212	7	2.8	1.7	1.2	3.0
Sugar & Molasses[4]	-	L	all	152	-	3.2	0.9	1.3	2.1
	-	U	1,2	383	-	3.7	0.9	1.1	2.9
	-	U	3.4	383	-	3.5	0.9	1.1	2.6
Primary Metal Products	-	-	1,4	159	6	2.3	1.7	0.7	2.5
	-	-	2	159	12	3.0	1.7	1.3	3.1
	-	-	3	159	5	2.2	1.7	0.7	2.5
Scrap Metals	-	-	1,4	127	5	0.5	1.7	0.3	2.0
	-	-	2	127	10	1.0	1.7	0.4	2.1
	-	-	3	127	4	0.4	1.7	0.3	2.0
Construction Materials	-	L	1,2	1,538	119	5.0	0.3	0.6	1.0
	-	L	3,4	1,538	80	2.8	0.3	0.4	0.8
	-	U	1,2	844	153	5.5	0.3	0.6	1.0
	-	U	3,4	844	66	2.6	0.3	0.4	0.8

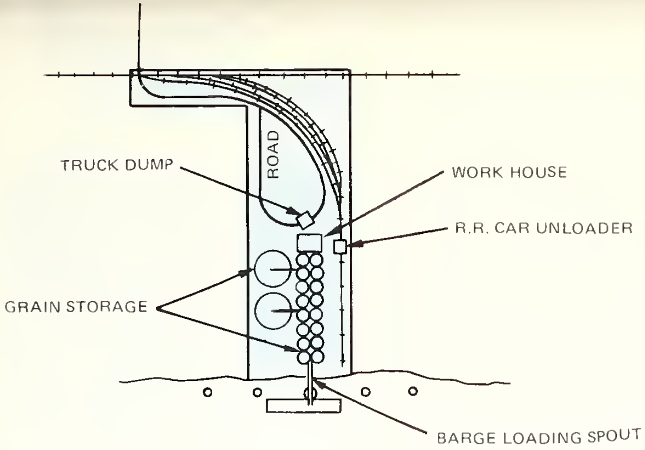
---

[1] Amount which can be stored at any instant, i.e., capacity with no turnover of storage facilities. Instantaneous storage capacity was not input to the Cost Allocation Model and is shown here for informational purposes only.

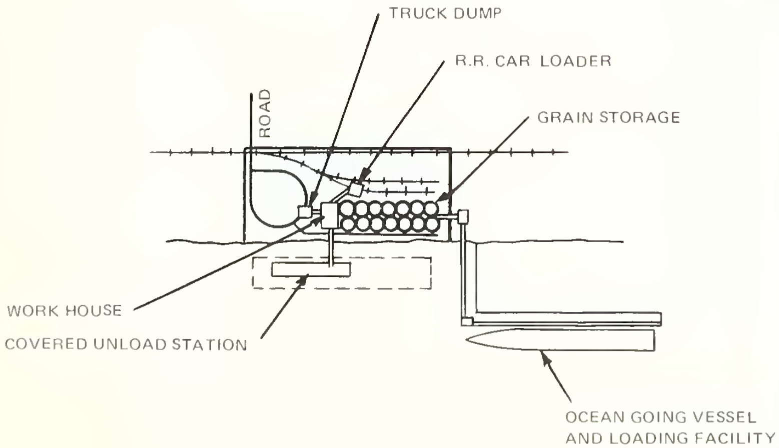
[2] 1978 dollars.

[3] Total cost does not include financial or real estate costs.

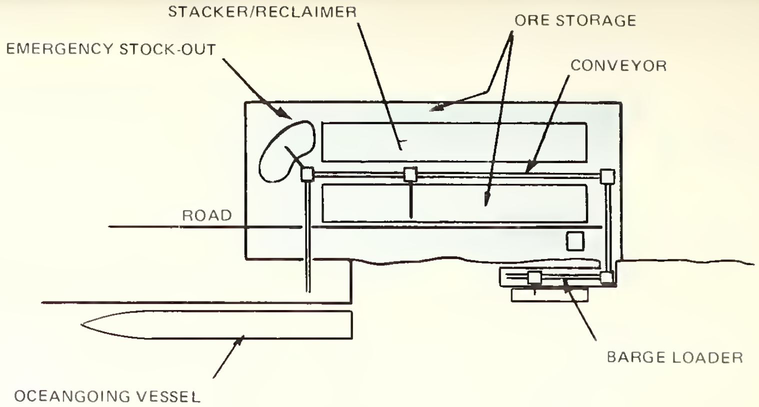
[4] Costs and land requirements for Sugar & Molasses were developed from separate conceptual terminals for each commodity.


TRUCK DUMP
ROAD
WORK HOUSE
R.R. CAR UNLOADER
GRAIN STORAGE
BARGE LOADING SPOUT

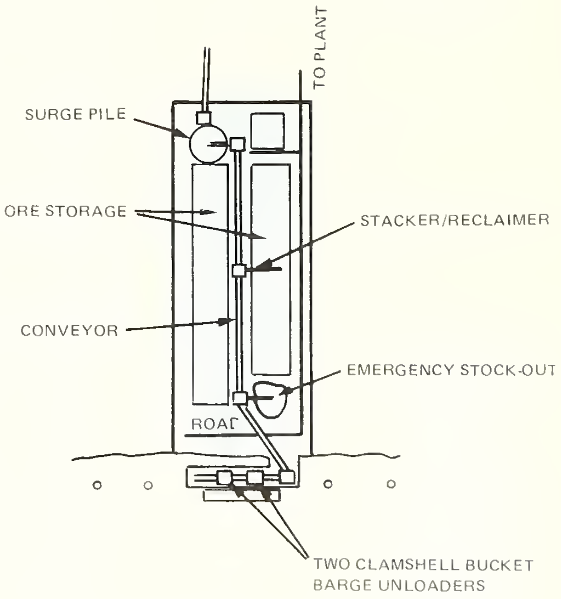
A. GRAIN LOADING
(SUPER REGIONS – 1, 2)


TRUCK DUMP
R.R. CAR LOADER
ROAD
GRAIN STORAGE
WORK HOUSE
COVERED UNLOAD STATION
OCEAN GOING VESSEL
AND LOADING FACILITY

B. GRAIN, UNLOADING
(SUPER REGIONS – 3, 4)


STACKER/RECLAIMER
ORE STORAGE
EMERGENCY STOCK-OUT
CONVEYOR
ROAD
BARGE LOADER
OCEANGOING VESSEL

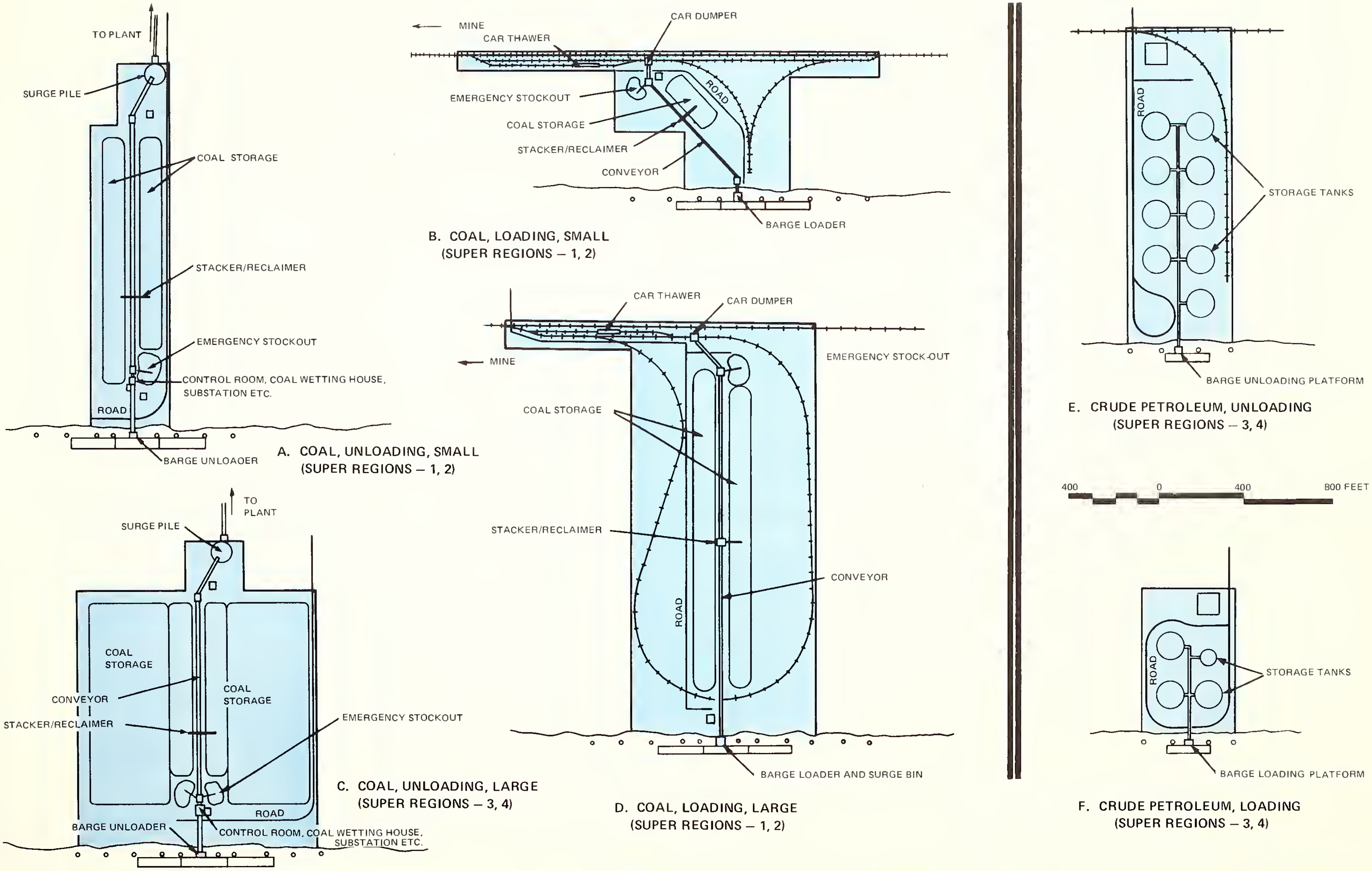
C. ORE, LOADING
(SUPER REGIONS – 3, 4)


TO PLANT
SURGE PILE
ORE STORAGE
STACKER/RECLAIMER
CONVEYOR
EMERGENCY STOCK-OUT
ROAD
TWO CLAMSHELL BUCKET
BARGE UNLOADERS

D. ORE, UNLOADING
(SUPER REGIONS -- 1, 4)

400
0
400
800 FEET

FIGURE 35 CONCEPTUAL TERMINAL DEVELOPMENT PLANS : GRAIN AND ORE



TO PLANT
SURGE PILE
COAL STORAGE
STACKER/RECLAIMER
EMERGENCY STOCKOUT
CONTROL ROOM, COAL WETTING HOUSE, SUBSTATION ETC.
ROAD
BARGE UNLOAOER
MINE
CAR THAWER
CAR DUMPER
EMERGENCY STOCKOUT
COAL STORAGE
STACKER/RECLAIMER
CONVEYOR
ROAD
BARGE LOADER
TO PLANT
SURGE PILE
COAL STORAGE
CONVEYOR
STACKER/RECLAIMER
COAL STORAGE
EMERGENCY STOCKOUT
ROAD
BARGE UNLOADER
CONTROL ROOM, COAL WETTING HOUSE, SUBSTATION ETC.
CAR THAWER
CAR DUMPER
MINE
EMERGENCY STOCK-OUT
COAL STORAGE
STACKER/RECLAIMER
CONVEYOR
ROAD
BARGE LOADER AND SURGE BIN
ROAD
STORAGE TANKS
BARGE UNLOADING PLATFORM
400
0
400
800 FEET
ROAD
STORAGE TANKS
BARGE LOADING PLATFORM

A. COAL, UNLOADING, SMALL
(SUPER REGIONS – 1, 2)

B. COAL, LOADING, SMALL
(SUPER REGIONS – 1, 2)

C. COAL, UNLOADING, LARGE
(SUPER REGIONS – 3, 4)

D. COAL, LOADING, LARGE
(SUPER REGIONS – 1, 2)

E. CRUDE PETROLEUM, UNLOADING
(SUPER REGIONS – 3, 4)

F. CRUDE PETROLEUM, LOADING
(SUPER REGIONS – 3, 4)

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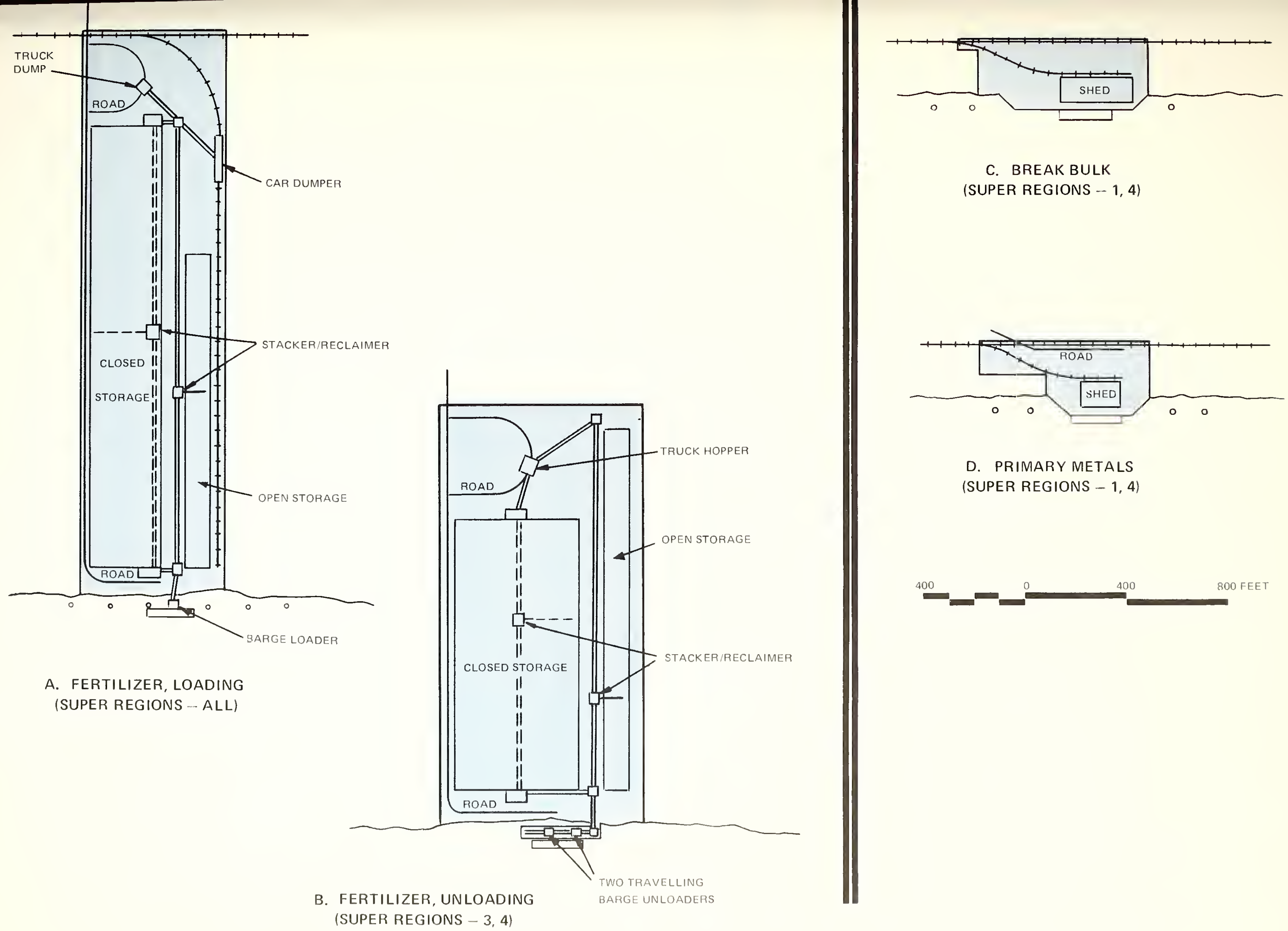
FIGURE 36 CONCEPTUAL TERMINAL DEVELOPMENT PLANS : COAL AND CRUDE OIL


TRUCK DUMP
ROAD
CAR DUMPER
STACKER/RECLAIMER
CLOSED STORAGE
OPEN STORAGE
ROAD
BARGE LOADER
TRUCK HOPPER
ROAD
OPEN STORAGE
CLOSED STORAGE
STACKER/RECLAIMER
ROAD
TWO TRAVELLING BARGE UNLOADERS
SHED
ROAD
SHED
400
0
400
800 FEET

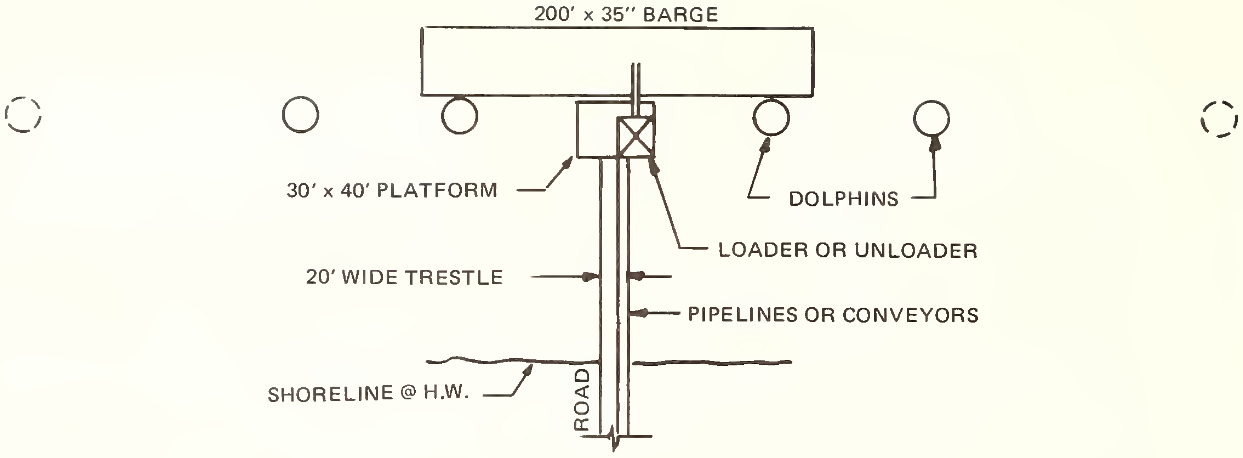
A. FERTILIZER, LOADING
(SUPER REGIONS -- ALL)

B. FERTILIZER, UNLOADING
(SUPER REGIONS – 3, 4)

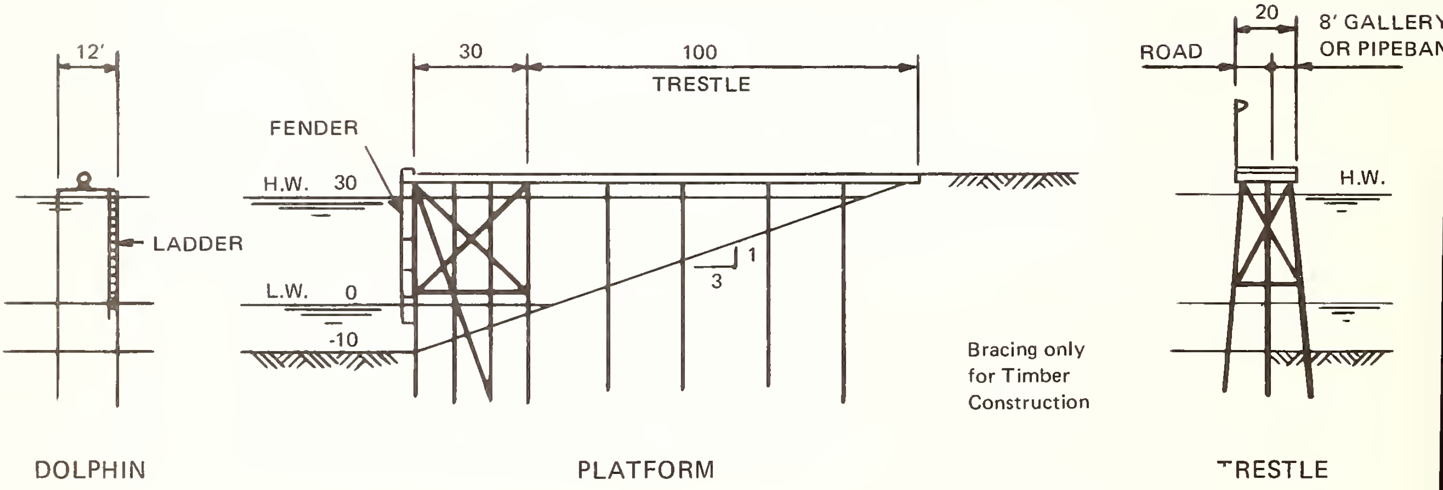
C. BREAK BULK
(SUPER REGIONS -- 1, 4)

D. PRIMARY METALS
(SUPER REGIONS – 1, 4)

FIGURE 37 CONCEPTUAL TERMINAL DEVELOPMENT PLANS : FERTILIZER AND BREAK BULK


200′ x 35″ BARGE
30′ x 40′ PLATFORM
DOLPHINS
LOADER OR UNLOADER
20′ WIDE TRESTLE
PIPELINES OR CONVEYORS
SHORELINE @ H.W.
ROAD

PLAN
1″ = 100′


12′
LADDER
DOLPHIN
30
100
TRESTLE
FENDER
H.W. 30
L.W. 0
-10
1
3
PLATFORM
20
ROAD
8′ GALLERY
OR PIPEBAN
H.W.
TRESTLE

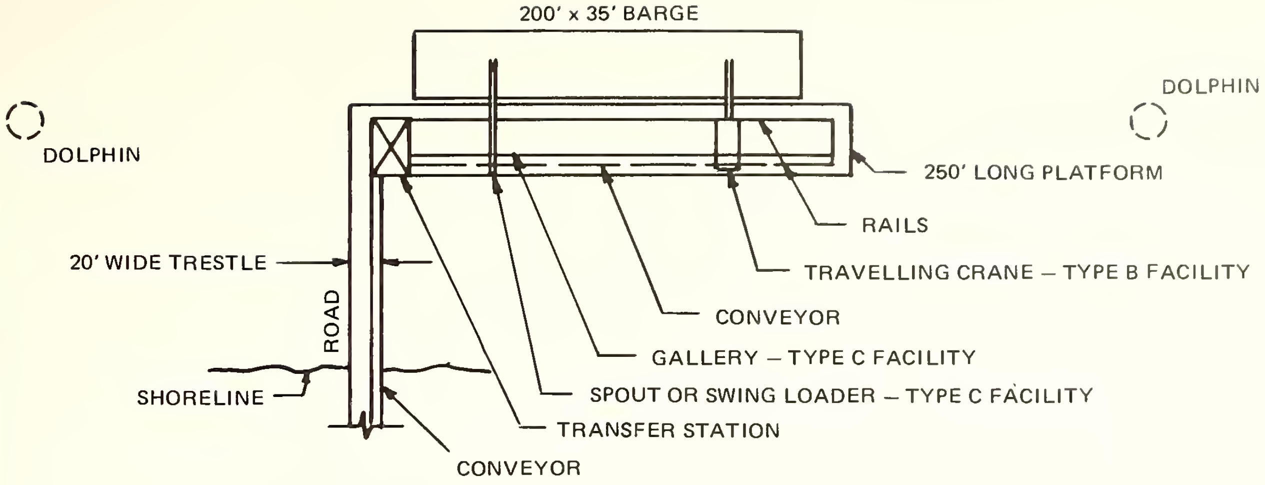
Bracing only for Timber Construction

SECTIONS
1″ — 50′

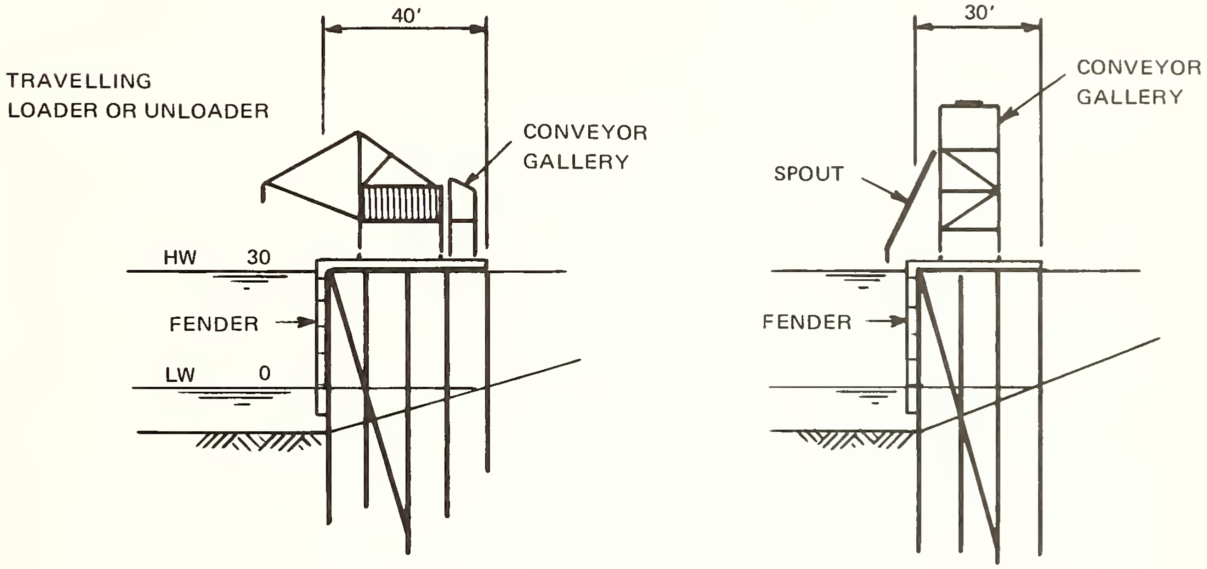
NOTE: MATERIAL HANDLING EQUIPMENT NOT SHOWN

TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 34A TYPICAL WHARF STRUCTURES : TYPE A


200′ x 35′ BARGE
DOLPHIN
DOLPHIN
250′ LONG PLATFORM
RAILS
TRAVELLING CRANE – TYPE B FACILITY
20′ WIDE TRESTLE
ROAD
CONVEYOR
GALLERY – TYPE C FACILITY
SHORELINE
SPOUT OR SWING LOADER – TYPE C FACILITY
TRANSFER STATION
CONVEYOR

PLAN
1″ = 100″


40′
TRAVELLING
LOADER OR UNLOADER
CONVEYOR
GALLERY
HW 30
FENDER
LW 0
30′
CONVEYOR
GALLERY
SPOUT
FENDER

PLATFORM – TYPE B FACILITY

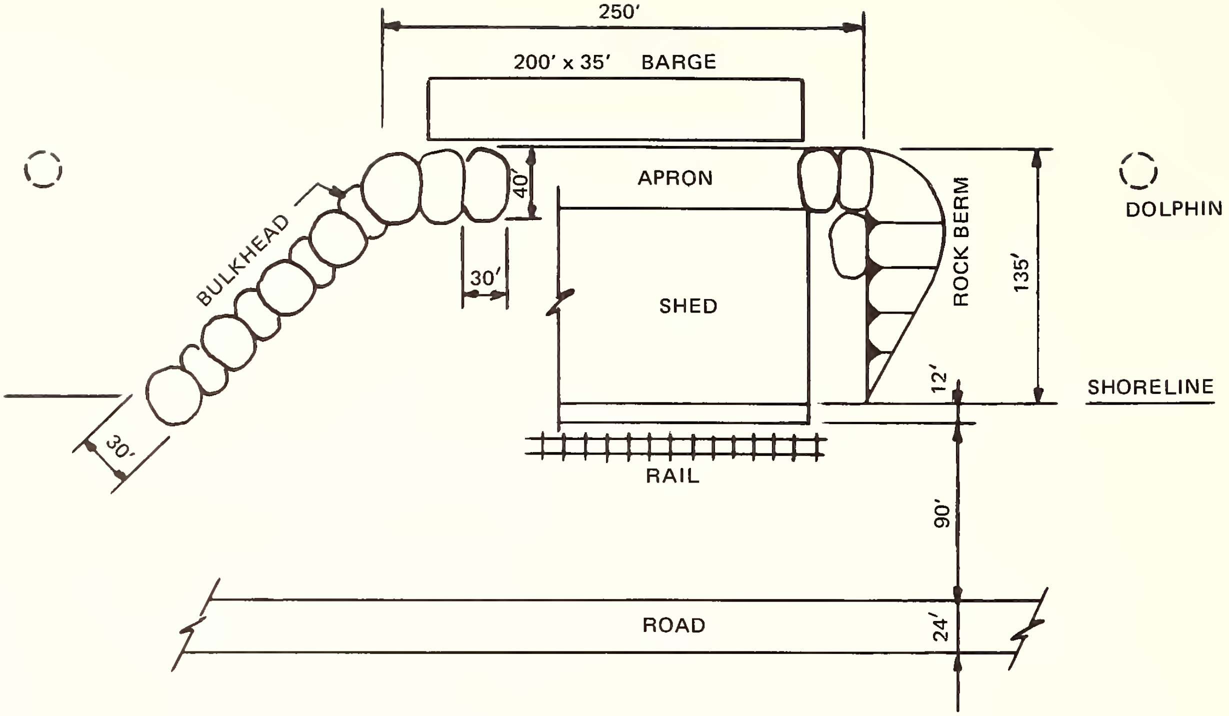
PLATFORM – TYPE C FACILITY

SECTIONS
1″ = 50′

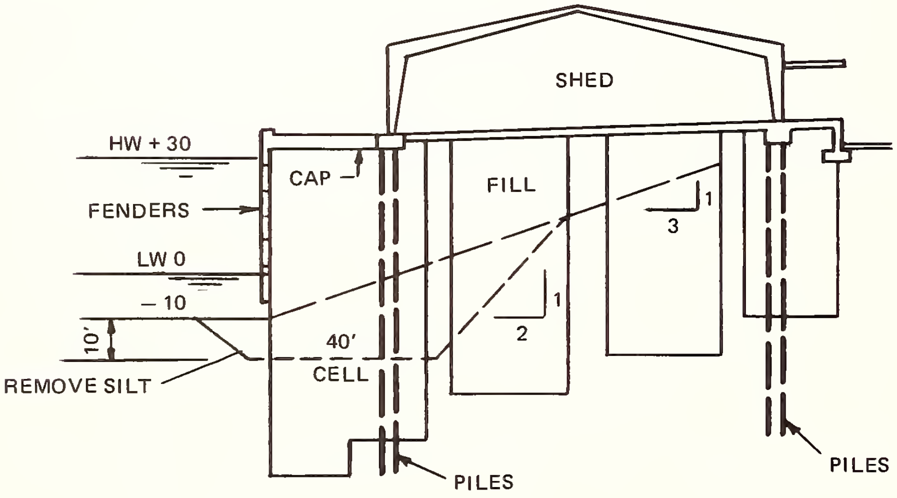
NOTE: TRESTLE STRUCTURE SIMILAR TO TYPE A

TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 34B TYPICAL WHARF STRUCTURES : TYPES B AND C


250'
200' x 35' BARGE
APRON
40'
30'
BULKHEAD
SHED
ROCK BERM
135'
DOLPHIN
12'
SHORELINE
30'
RAIL
90'
ROAD
24'

PLAN
1" = 100'


SHED
HW + 30
CAP
FILL
FENDERS
1
3
LW 0
1
2
− 10
10'
40'
CELL
REMOVE SILT
PILES
PILES

TYPE D — BREAK BULK CARGO FACILITY

SECTION
1" = 50'

TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 34C TYPICAL WHARF STRUCTURES : TYPE D

Ores (Figures 35c, d) - The unloading terminal for superregions 3 and 4[1] (Figure 35c) is an import facility using a stacker/reclaimer with a 100 ft. boom. Other facilities employ 240 ft. booms.

Coal (Figures 36a, b, c, d) - Stacker/reclaimers have 100 ft. booms. Some of the large terminals (e.g. Fig. 36c) have both active and reserve storage piles.

Liquid Bulks - Crude petroleum terminals (Figures 36e, f) were estimated on the basis of 50,000 bbl storage tanks. Smaller tanks of 20,000 bbl instantaneous capacity were used for petroleum products and industrial chemicals terminals. The cost of protective dikes was considered part of the tank cost. Crude petroleum and petroleum products were assumed to contain 7 bbl per short ton; industrial chemicals were rated at 4.17 bbl per ton.

Fertilizer - Fertilizers may be handled as solid bulk, liquid bulk, or general cargo (in barrels or bags). An examination of the Mid-America port inventory indicated that the general cargo component of fertilizer movement on the inland waterways is relatively insignificant for costing purposes. All fertilizer was assumed to be in solid bulk form (Figures 37a, b).

Two sizes of stacker/reclaimer booms were used. The unloading terminal for superregions 1 and 2 uses two 200 ft. booms; other conceptual fertilizer terminals use one 100 ft. boom and one 200 ft. boom.

General Cargo (Figures 37c, d) - The illustrations of Break Bulk and Primary Metals terminals are representative of Lumber and Wood Products facilities as well. Scrap Metal terminals were costed assuming a general cargo wharf as shown in Figures 37c, d, but no shed or railroad.

---

[1] Superregion 1 = Kentucky, Ohio, Pennsylvania, West Virginia;
Superregion 2 = Illinois, Iowa, Kansas, Minnesota, Missouri, Nebraska, Wisconsin;
Superregion 3 = Arkansas, Louisiana, Oklahoma;
Superregion 4 = Alabama, Mississippi, Tennessee.

Sugar and Molasses - These two commodities were combined for forecasting purposes; however, their handling characteristics are quite different. Molasses is handled as a liquid bulk, while bulk raw sugar is handled in solid form. Conceptual terminal costs and land requirements were estimated by developing separate conceptual terminals for both sugar and molasses, and taking a weighted average as follows:

> Loading facility requirements = Molasses loading requirements;
>
> Unloading facility requirements = 2/3 (Molasses unloading requirements) + 1/3 (Sugar unloading requirements).

The density of molasses varies greatly with temperature and purity. For converting barrels to tons, a density of 52 pounds per cubic foot was used. At that density, a typical handling rate of 400 bph corresponds to 56 tph. Actual handling rates in tph can be higher, but this is offset by the time needed to steam the molasses before handling.

Construction Materials - This facility type handles materials with a wide range of terminal facility requirements. Waterway improvement materials are commonly picked up or discharged in midstream by dredging equipment, and require no terminal facilities. Some construction materials terminals consist of nothing more than a riverbank on which barges are beached and loaded by cranes. On the other hand, cement terminals require heavy investments in pumps, tanks and agitators; and some large terminals use conveyor systems for sand or gravel.

The conceptual terminals used for construction materials are fairly simple: open pile storage is used for a sand-like commodity, handling equipment comprises a crane and perhaps a gravity chute, and two sunken barges provide a wharf structure.

CHAPTER 18

MID-AMERICA PORT FACILITY REQUIREMENTS

Over $9 billion in new port facility investment will be required in the 20-year period, 1980-2000, to satisfy the cumulative projected cargo handling deficit of 691 million short tons. This investment will go for the construction of about 1,000 new barge berths and the development of between 10,000 and 11,000 acres of waterfront land; about 17 million cubic yards of dredge material resulting from berth construction alone will require disposal.

This chapter briefly describes the methodology employed to develop facility requirements and summarizes the study findings for two alternative facility development scenarios. An example is given which demonstrates the computation of capacity, deficits, and required investment and land area for a hypothetical subregion.

COST ALLOCATION MODEL

The Cost Allocation Model (CAM) is a computer-programmed model which computes and tabulates total and incremental costs to upgrade port facilities for the four target years -- 1980, 1985, 1990 and 2000 -- for each of the 15 cargo handling groups in each subregion of the 17-state study area. Figure 38 is a flow chart depicting the principal elements of the model. Costs and facility needs are related to the projected capacity deficits.

Two cargo capacities are computed: (1) the vessel to apron transfer capacity and (2) the storage capacity. An initial objective of the model is to identify and estimate the cost of eliminating any imbalance between the apron and storage elements of capacity in each subregion. An imbalance exists when the forecast demand exceeds the capacity of one element, but not of the other. Where the forecast traffic exceeds the annual capacities for both elements, costs will have to be incurred in constructing a new facility -- or "module" -- which consists of expanding both the apron and storage capacity levels to remove the projected capacity deficiencies.

The input to the model includes the following:

1. Subregion handling capacity and forecast data. These are outputs from other models which must be run before the CAM. The capacity data are stratified by loading and discharging facilities for each commodity group of the subregion. The traffic forecast data have the same stratification as do the capacity data for each of the four target years.

2. Geographic data. These include a state code to modify facility sizes by region, and a percentage split by different size facility for selected commodity groups in certain states.

3. Cost data. These include the costs of berths, site preparation, and material handling equipment separately for loading and discharging and by apron and storage facilities, for each commodity handling group. The loading and discharging capacities for each facility type are also input so that unit costs per ton ($/ton) may be specified.

The basic hierarchy of events during analysis is commodity level, year, then load versus discharge. Calculations are made at the lowest level (e.g. load or discharge).

The calculation for capacity to-be-provided is accomplished by comparing the capacity deficit of the current time period being analyzed and the next time period five years hence. The "target deficit" is the average of these two values. For the year 2000 an extrapolation using 1990 data provides the target deficit. The reason for choosing a target deficit which is higher than the actual deficit in the time period being analyzed is that when terminals are built, they are generally built with excess capacity in anticipation of greater future demands. Target and actual deficits are included in the printout.

The CAM provides an option in which terminals whose condition was described in the inventory as "poor" can be assumed to reach obsolescence by 1990; their capacities can be excluded from subregional capacities for the years 1990 and 2000. However, the contribution of "poor" facilities to subregional capacities was found to be negligible and this option of the CAM was not exercised in preparing this report.

To satisfy a deficit, the system first looks for opportunities to upgrade the apron, then the storage area, and, as necessary, provide new facilities -- in that order. Thus, the computer printout -- through the four time periods -- shows capacity being met first by apron upgrading then storage upgrading and finally provision of new facilities. The target deficit equals the actual capacity deficit plus the excess required to meet the target deficit as explained previously. The excess, however, will only be built if new facilities are required. In other words, if apron and/or storage upgrading potential are greater than actual capacity deficit then only the amount equivalent to the capacity deficit will be accomplished for upgrading.

Once the facilities to be provided by the three categories (apron, storage and new) are calculated, then costs, numbers of modules and land areas are computed directly using the unit input data shown in Chapter 17. In the case of two facility sizes to serve a commodity, the percent large and small specified is applied directly to the capacity to be provided for each of the three categories. The calculation for number of modules, storage area and costs are straightforward.

For each subregion, a computer output table contained in Appendix K lists for each commodity group: the capacity deficit and the total upgrading cost ($) for each of the four target years, as well as the incremental cost between the target years. For each state, a summary of all subregion quantities is produced, by each commodity group and then a grand total.

Alternative Facility Development Scenario

Two alternative facility development scenarios were considered for five terminal cargo handling types in which significant handling deficits are projected: coal, grains, petroleum products, crude petroleum and chemicals. As it developed, facility development associated with these five commodities, accounted for over 80 percent of the total study area development costs. For the other commodity groups, only one facility size was considered.

The scenarios revolve around the distribution of "large" and "small" facilities that will be constructed to satisfy future needs within a commodity group. For example, a development program for Mid-America entailing greater consolidation of port terminals can be translated, for purposes of this analysis, into a scenario in which there is a higher percentage of large facilities than at present. Large and small facilities were defined in Chapter 17. Economy of scale, the magnitude of which varies by commodity, can be realized through construction of larger facilities; significant economies of scale, measured in dollars ($) of construction per ton -- cost/ton -- can be realized with coal; on the other hand, only nominal cost/ton savings are possible for liquid bulk facilities.

Table 18-1 summarizes the assumptions utilized in the two scenarios. Scenario 1 approximates the current distribution of large and small facilities in the 17-state study area. Scenario 2 reflects a greater proportion of large facilities than at present.

TABLE 18-1

ALTERNATIVE FACILITY DEVELOPMENT SCENARIOS
(Distribution of Small and Large Facilities)

Facility Type	Percent of Small Facilities (%)		Percent of Tonnage Handled by Small Facilities (%)	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2
Grains	80	50	53	22
Coal	75	25	23	3
Crude Petroleum	50	40	33	25
Petroleum Products	40	30	25	18
Chemicals	40	30	25	18

All other commodity groups -- one size facility utilized.

Note: Scenario 1 approximates the existing distribution between large and small facilities.

DEVELOPMENT NEEDS

Table 18-2 summarizes the forecast cumulative 20-year development costs, acreage requirements and berth requirements, by state, to satisfy the projected cumulative cargo handling deficit of 691 million short tons.

Under Scenario 1, $9.7 billion in development costs, 11,039 acres, 1,178 new terminal modules and 1,132 new berths will be required for the total 17-state study area. Under Scenario 2 these figures are only slightly less -- $9.4 billion, 10,317 acres, 1,019 new modules and 992 new berths. Most of the difference between scenarios is attributable to coal handling facilities.

The greatest needs are in Louisiana: $4.1 billion (42 percent of total costs); 3,738 acres (34 percent of the total); and 485 berths (43 percent of the total) under Scenario 1. Alabama, with an investment of $1.3 billion ranks second, followed by Arkansas and Mississippi.

Tables 18-3a and 18-3b summarize the 20-year development needs for coal, petroleum products, grains, fertilizers and chemical handling facilities, by state, for Scenarios 1 and 2, respectively. These five facility types account for over 80 percent of the total study area development costs and acreage requirements and about 50 percent of the projected new berths.

Coal facility costs under Scenario 1 exceed the costs and acreage needs under Scenario 2 by $240 million and 260 acres, respectively. As can be seen in the tables, coal handling facility development benefits most from the economies-of-scale introduced by going to a larger facility. Coal development needs are the greatest in Ohio, Illinois and Alabama. Total study area investment costs vary from $668 million to $912 million and areal requirements range from 2,226 acres to 2,785 acres.

TABLE 18-2

FORECAST CUMULATIVE DEVELOPMENT COSTS, ACREAGE AND BARGE BERTHS, BY STATE
BY STATE, YEAR 1980-2000

	Scenario No. 1 - Large % Small Facilities						Scenario No. 2 - Small % Small Facilities					
			No. Modules						No. Modules			
State	Cumulative Cost ($ million)	Total Acres	Total	New	Upgrade	New* Berths	Cumulative Cost ($ million)	Total Acres	Total	New	Upgrade	New Berths
Alabama	1,264	1,705	226	214	12	224	1,228	1,615	219	198	11	219
Arkansas	869	969	66	65	1	65	856	947	59	59	--	59
Illinois	726	785	66	59	7	62	681	660	47	41	6	43
Iowa	113	41	8	4	4	4	113	35	6	3	3	3
Kansas	--	--	--	--	--	--	--	--	--	--	--	--
Kentucky	654	849	43	42	1	43	637	811	36	35	1	36
Louisiana	4,137	3,738	509	412	97	485	4,069	3,620	461	369	92	440
Minnesota	21	48	7	2	5	6	17	43	4	1	3	4
Mississippi	763	840	72	65	7	71	745	810	64	57	7	63
Missouri	389	519	46	42	4	45	357	430	33	30	3	32
Nebraska	--	--	--	--	--	--	1	2	1	--	--	--
Ohio	239	696	38	31	7	35	189	574	19	15	4	17
Oklahoma	50	19	4	4	--	4	49	15	3	3	--	3
Pennsylvania	115	235	17	12	5	16	100	203	10	8	2	10
Tennessee	269	318	56	52	4	53	262	296	52	48	4	49
West Virginia	113	263	18	16	2	17	102	244	14	12	2	13
Wisconsin	17	14	2	1	1	2	16	12	1	1	--	1
Totals	9,739	11,039	1,178	1,021	157	1,132	9,422	10,317	1,019	880	138	992

---

* Includes both upgrading and new facilities, the latter being predominant.

Source: Tippetts-Abbett-McCarthy-Stratton

TABLE 18-3a

SCENARIO NO. 1
DEVELOPMENT REQUIREMENTS (1980-2000)
COAL, PETROLEUM PRODUCTS, GRAINS, FERTILIZERS AND CHEMICALS

	Coal		Petroleum Products		Grains		Fertilizers		Chemicals	
State	$(millions)	Acres/ Modules	$(millions)	Acres/ Modules	$(millions)	Acres/ Modules	$(millions)	Acres/ Modules	$(millions)	Acres/ Modules
Alabama	$113.5	359/19.1	$ 282.7	303/12.9	$ 22.4	8/1.9	$ 4.5	3/0.3	$186.8	200/9.7
Arkansas	37.7	84/6.6	731.9	784/32.7	24.4	9/2.0	9.0	8/0.5	30.7	33/1.3
Illinois	146.7	446/22.9	100.8	110/9.9	342.8	90/17.4	69.0	53/1.7	41.7	44/2.5
Iowa	0.1	--	--	--	99.4	28/5.2	8.2	7/0.2	--	--
Kansas	--	--	--	--	--	--	--	--	--	--
Kentucky	62.4	223/9.0	486.0	513/18.2	25.8	7/1.2	0.1	--	57.8	61/2.5
Louisiana	52.3	116/9.2	1,732.8	1,904/125.7	746.2	299/81.8	645.7	446/26.8	382.4	415/27.0
Minnesota	14.9	47/3.7	--	--	4.9	0/2.3	--	--	--	--
Mississippi	57.3	127/10.0	557.7	602/30.8	13.6	5/1.7	80.3	55/3.5	2.3	2/0.1
Missouri	108.3	312/17.2	65.8	69/3.3	114.0	30/6.0	50.6	39/1.2	3.7	4/0.3
Nebraska	--	--	--	--	--	--	--	--	--	--
Ohio	192.8	646/31.9	12.2	14/2.0	2.5	1/0.1	19.0	15/0.4	2.1	2/0
Oklahoma	--	--	--	--	48.0	17/3.9	16.4	1/0	--	--
Pennsylvania	55.9	172/10.7	43.1	45/2.3	1.9	1/0.1	--	--	--	--
Tennessee	21.8	73/4.3	61.3	68/5.6	37.1	13/3.0	6.0	4/0.2	54.6	58/2.4
West Virginia	44.8	171/7.1	41.7	47/3.8	--	--	8.2	6/0.1	6.3	7/0.7
Wisconsin	3.6	9/0.9	--	--	12.8	3/0.6	0.5	--	--	--
Totals	$912.1	2,785/152.6	$4,116.0	4,459/247.2	$1,495.8	511/127.2	$917.5	637/34.9	$768.4	826/46.5

Source: Tippetts-Abbett-McCarthy-Stratton

TABLE 18-3b

SCENARIO NO. 2
DEVELOPMENT REQUIREMENTS (1980-2000)
COAL, PETROLEUM PRODUCTS, GRAINS, FERTILIZERS AND CHEMICALS

State	Coal		Petroleum Products		Grains		Fertilizers		Chemicals	
	$(millions)	Acres/ Modules	$(millions)	Acres/ Modules	$(millions)	Acres/ Modules	$(millions)	Acres/ Modules	$(millions)	Acres/ Modules
Alabama	$ 83.1	277/8.0	$ 282.0	301/12.1	$ 21.7	6/1.3	$ 4.5	3/0.3	$186.3	199/9.1
Arkansas	27.5	68/2.7	730.2	779/30.8	23.8	7/1.4	8.9	8/0.5	30.7	33/1.2
Illinois	105.9	341/9.6	100.3	109/9.3	338.9	72/12.3	69.0	44/2.3	41.5	44/2.3
Iowa	--	--	--	--	98.6	22/3.7	8.2	7/0.2	--	--
Kansas	--	--	--	--	--	--	--	--	--	--
Kentucky	46.9	190/3.7	485.2	510/17.0	25.4	5/0.8	--	--	57.7	61/2.4
Louisiana	38.1	94/3.8	1,727.0	1,884/118.0	699.9	227/49.4	645.7	446/26.8	381.1	411/25.4
Minnesota	11.2	42/1.5	--	--	4.6	0/1.6	--	--	--	--
Mississippi	41.7	103/4.2	556.0	598/29.0	13.3	4/1.2	80.3	55/3.5	2.3	2/0.1
Missouri	77.3	230/7.2	65.7	68/3.1	112.4	24/4.2	50.6	39/1.2	3.7	4/0.2
Nebraska	--	--	--	--	--	--	--	--	--	--
Ohio	142.3	525/13.3	12.1	14/1.9	2.5	1/0	19.0	15/0.4	2.1	2/0
Oklahoma	--	--	--	--	46.9	14/2.8	1.6	1/0	--	--
Pennsylvania	41.3	141/4.4	42.9	45/2.2	1.8	--	--	--	--	--
Tennessee	16.0	55/1.8	61.0	67/5.2	36.3	10/2.1	6.0	4/0.2	54.4	58/2.2
West Virginia	34.4	152/2.9	41.6	46/3.6	--	--	8.2	6/0.1	6.2	7/0.6
Wisconsin	2.7	8/0.3	--	--	12.7	3/0.4	0.5	1/0.4	--	--
	$668.4	2,226/63.4	$4,104.0	4,421/232.2	$1,438.8	395/81.2	$902.5	628/35.5	$766.0	821/43.5

Source: Tippetts-Abbett-McCarthy-Stratton

Petroleum product handling facilities require a cumulative 20-year investment of $4.1 billion, or 42 to 44 percent of the total 17-state development costs. $1.7 billion of this amount will be expended in Louisiana and $730 million in Arkansas. Over 4,000 acres of land will be required for these facilities throughout the study area.

Grain facilities account for 15 percent of the total development costs, almost 50 percent of which will be expended in Louisiana; 24 percent of the costs will be incurred in Illinois, the state with the second largest need for grain facilities.

Fertilizer and chemical handling facilities combined will cost $1.7 billion, or about 18 percent of the total costs.

Table 18-4 summarizes the annual development costs by target year and by state. Figure 39 shows forecast development needs by state.

EXAMPLE: COMPUTATION OF CAPACITY, DEFICIT AND COSTS

The following example is provided to illustrate the process used in computing subregional capacity and projected deficits and costs.

For simplicity, the example considers only one commodity group (primary metal products) and one forecast year (1985).

A hypothetical subregion is considered, located in superregion 2. Inbound and outbound commerce in primary metal products is forecast as 800,000 tons in 1985 and 1,200,000 tons in 1990.

The subregion contains only one terminal handling primary metal products, and no other commodity is handled at that terminal. The terminal has two barge berths, two cranes and 150,000 square feet of storage area. However, the cargo handling rate of the cranes is unknown, i.e. was not reported on the inventory form.

The general procedure can be summarized as follows.

TABLE 18-4

ANNUAL INVESTMENT SCHEDULE
BY STATE, ALL COMMODITIES
ALTERNATIVE SCENARIO NO. 2
($ Millions)

State	1980	1985	1990	2000
Alabama	143.6	217.5	340.0	527.2
Arkansas	140.9	108.7	237.9	368.7
Illinois	181.6	91.6	112.7	294.9
Iowa	15.6	4.6	4.5	87.9
Kansas	24*	--	--	--
Kentucky	101.7	82.5	176.1	277.2
Louisiana	334.7	499.8	1,082.6	2,152.3
Minnesota	3.9	0.9	1.7	10.9
Mississippi	30.4	91.2	210.6	413.1
Missouri	53.3	53.7	93.3	156.3
Nebraska	11*	28*	50*	608*
Ohio	8.8	19.5	60.4	100.2
Oklahoma	15.9	10.3	9.5	13.1
Pennsylvania	7.5	8.9	38.2	45.3
Tennessee	36.9	39.0	65.0	120.9
West Virginia	19.4	21.5	23.1	38.0
Wisconsin	4.7	.9	3.9	6.9
	1,098.9	1,250.6	2,459.5	4,613.5

---

* $ thousands

First, the subregion's cargo handling capacity is computed. This capacity is then compared to forecast commerce flows to determine whether the subregion has excess capacity. If capacity is less than projected commerce, a capacity deficit exists. The cost of providing sufficient capacity to offset the deficit is then computed.

Subregional Capacity

In general, a subregion's capacity to handle a given commodity flow is the sum of the capacities of individual terminals to handle that commodity flow. In this example, the subregional capacity in primary metal products is equal to the capacity of a single terminal.

As defined in Chapter 15, terminal capacity is the lesser of two elements: vessel to apron transfer capacity (C_B) and terminal storage capacity (C_s).

1. Vessel to Apron Transfer Capacity

This quantity may also be termed apron capacity or berth capacity. Apron capacity is computed by the equation:

$$C_B = H \times G \times W \times B \times P \times Q \times R^*$$

In this case the factors G and B are known to equal 1 and 2, respectively. H is taken as 75 tons/hour.* Because there are two berths, the berth occupancy factor P is equal to 0.82.* The other factors are taken from Table 15-2. Inserting these values into the equation, C_B = (75 tons/hour per crane) x (1 crane/berth) x (3700 hours/year) x (2 berths) x 0.82 x 0.95 x 0.90 = 389,000 tons/year.

2. Terminal Storage Capacity

Storage capacity is likewise computed in accordance with Chapter 15.

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* As shown in Chapter 15.

$$C_s = \frac{365 \times A \times Q}{L \times D \times Y}$$

$$= \frac{(365 \text{ days/year}) \times (100{,}000 \text{ sq. ft.}) \times (0.95)}{(4.5 \text{ sq. ft./ton}) \times (30 \text{ days}) \times (0.90)}$$

$$= 285{,}000 \text{ tons/year}$$

The capacity of the terminal is limited by its storage capacity. Thus, the terminal capacity is equal to the storage capacity which is 285,000 tons/year.

Capacity Excess/Deficit

The level of capacity deficit in a given year equals the forecast volume of commerce for the subregion that year minus the subregional annual cargo handling capacity. Thus in 1985, the capacity deficit equals 800,000 tons - 285,000 tons = 515,000 tons. However, the 1985 target deficit (defined in this chapter under the heading "COST ALLOCATION MODEL") is based on the average of forecast commodity flows for 1985 and 1990. This average is ½ x (800,000 + 1,200,000) = 1,000,000 tons. The 1985 target deficit is then 1,000,000 - 285,000 = 715,000 tons. An additional 715,000 tons of annual cargo handling capacity will be provided in 1985.

Upgrading to Increase Capacity

Part of the target deficit can be met by upgrading storage capacity. Storage capacity will be upgraded until it equals the apron capacity. The amount of upgrading equals 389,000 - 285,000 = 104,000 tons.

The costs associated with storage upgrading are based on a conceptual terminal, or "module," with a 159,000 ton annual capacity (Table 17-8). (The same conceptual terminal would be used for apron upgrading or new facility construction.) The storage upgrading cost for that conceptual terminal is

$1,300,000. However, the capacity increase achieved by storage upgrading in this example is only 104,000 tons. Thus,

- Cost of storage upgrade $= \frac{104{,}000}{159{,}000} \times \$1{,}300{,}000$

  $= \$850{,}000$

- Number of Equivalent Modules $= \frac{104{,}000}{159{,}000} = 0.7$

- Land Area Required $= \frac{104{,}000}{159{,}000} \times (3.0 \text{ acres}) \times 0.90$

  $= 1.8$ acres,

where 3.0 acres is the area of an entire conceptual terminal. The 0.90 factor is introduced because land requirements for storage upgrading were reduced in the same proportion as site costs (Chapter 20, subtitle, Upgrading Costs).

By virtue of this storage upgrading, the subregional cargo handling capacity for primary metal products is increased to 389,000 tons/year.

The total storage capacity of the subregion is now equal to its total apron capacity. Any further capacity increases must be effected by adding both storage and apron facilities simultaneously. This is equivalent to constructing new terminals.

Adding New Facilities to Overcome Target Deficit

The addition of 104,000 tons/year of capacity by means of upgrading storage capacity reduces the target deficit to 715,000 - 104,000 = 611,000 tons/year. This remaining deficit will be met by building new facilities. As before, each capacity increase of 159,000 tons/year requires 3.0 acres of land; the corresponding cost of both storage and apron faciliti $3,100,000 (Table 17-8).

- Cost of new facilities $= \frac{611{,}000}{159{,}000} \times \$3{,}100{,}000 = \$11{,}913{,}000$
- Number of Equivalent Modules $= \frac{611{,}000}{159{,}000} = 3.8$

- Land Area Required = $\frac{611{,}000}{159{,}000}$ x (3.0 acres) = 11.5 acres

Total Cost and Land Requirement in 1985

- Total Cost = \$850,000 + \$11,913,000 = \$12,763,000
- Total Land Area Required = 1.8 acres + 11.5 acres = 13.3 acres

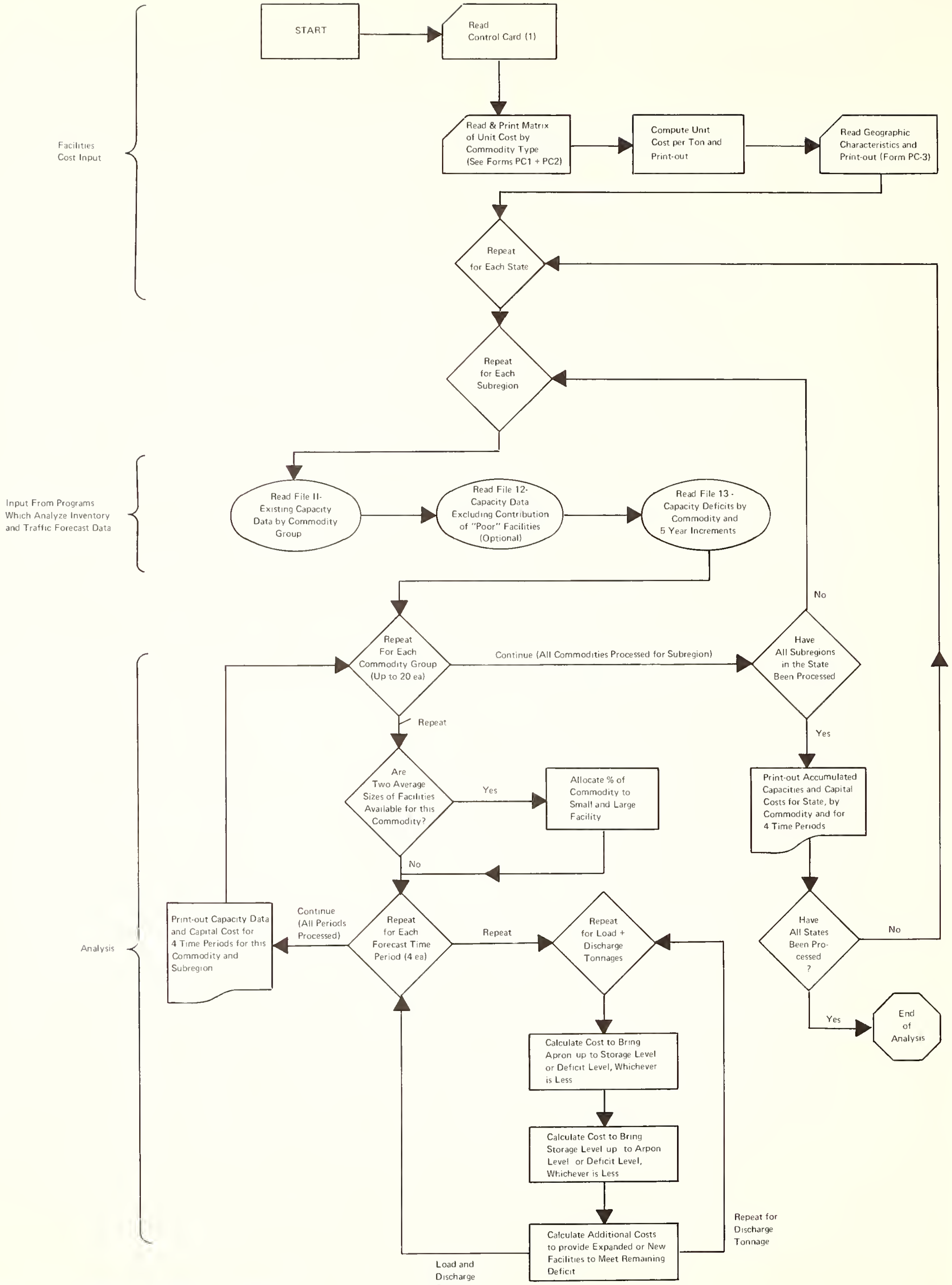
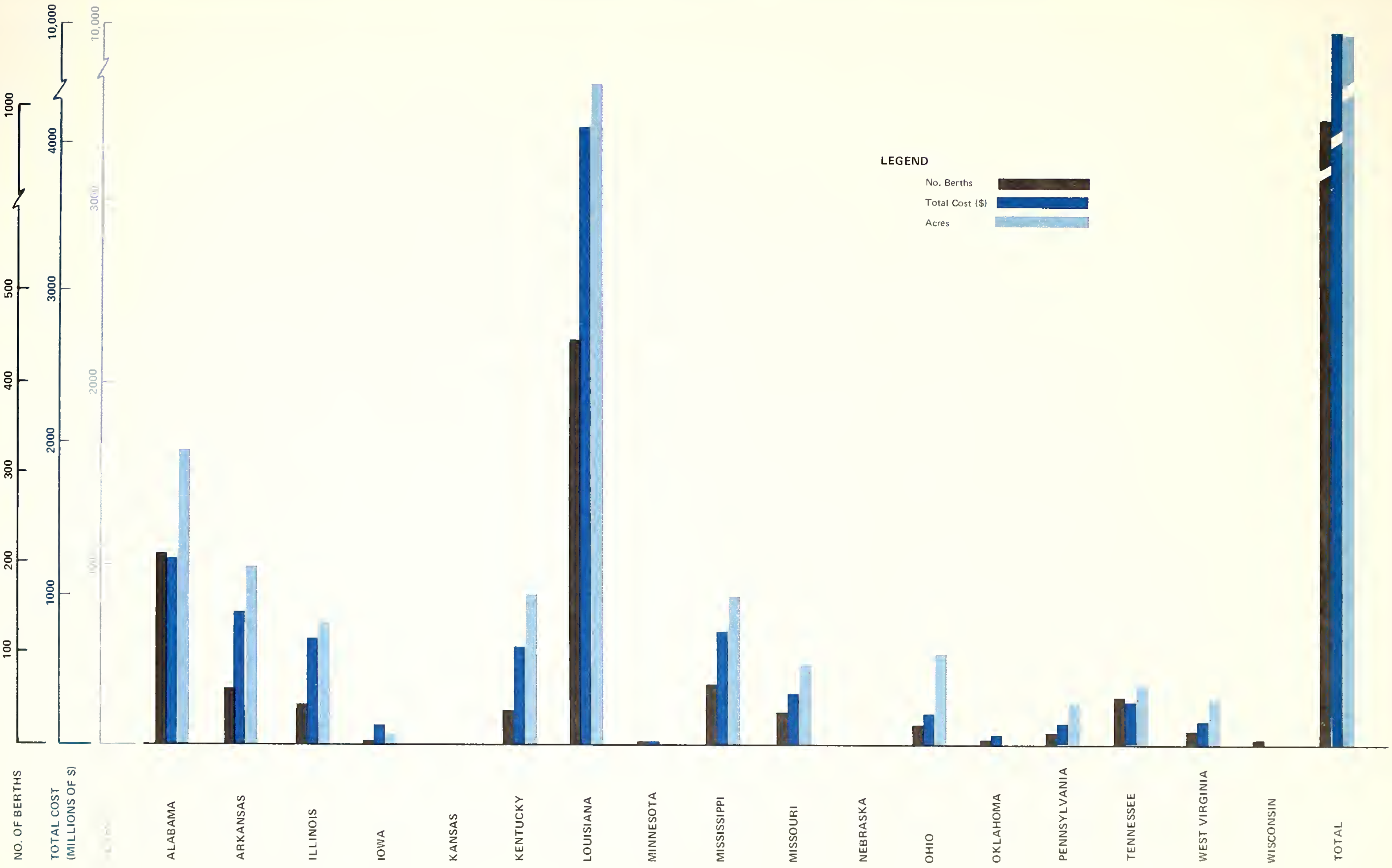

Facilities Cost Input
START
Read Control Card (1)
Read & Print Matrix of Unit Cost by Commodity Type (See Forms PC1 + PC2)
Compute Unit Cost per Ton and Print-out
Read Geographic Characteristics and Print-out (Form PC-3)
Repeat for Each State
Repeat for Each Subregion
Input From Programs Which Analyze Inventory and Traffic Forecast Data
Read File 11- Existing Capacity Data by Commodity Group
Read File 12- Capacity Data Excluding Contribution of "Poor" Facilities (Optional)
Read File 13 - Capacity Deficits by Commodity and 5 Year Increments
Analysis
Repeat For Each Commodity Group (Up to 20 ea)
Continue (All Commodities Processed for Subregion)
Have All Subregions in the State Been Processed
No
Yes
Repeat
Are Two Average Sizes of Facilities Available for this Commodity?
Yes
Allocate % of Commodity to Small and Large Facility
No
Print-out Accumulated Capacities and Capital Costs for State, by Commodity and for 4 Time Periods
Have All States Been Processed ?
No
Yes
End of Analysis
Print-out Capacity Data and Capital Cost for 4 Time Periods for this Commodity and Subregion
Continue (All Periods Processed)
Repeat for Each Forecast Time Period (4 ea)
Repeat
Repeat for Load + Discharge Tonnages
Calculate Cost to Bring Apron up to Storage Level or Deficit Level, Whichever is Less
Calculate Cost to Bring Storage Level up to Arpon Level or Deficit Level, Whichever is Less
Calculate Additional Costs to provide Expanded or New Facilities to Meet Remaining Deficit
Repeat for Discharge Tonnage
Load and Discharge Completed

FIGURE 38 COST ALLOCATION FLOW CHART



TIPPETTS-ABBETT-McCARTHY-STRATTON

FIGURE 39 FORECAST DEVELOPMENT NEEDS

CHAPTER 19

INSTITUTIONS FOR RIVERPORT PLANNING

A river terminal is a single node of a complex transportation network through which commodities move from origin to destination. Its function as a transsshipment point can not be divorced from the larger complex network. In this regard, riverport development in Mid-America, as elsewhere, has not been unplanned. It has evolved through a vast number of individual, piecemeal planning decisions, each aimed at meeting perceived needs for establishing a new facility, enlarging the capacity of an existing facility, or otherwise improving port services.

In the absence of a systemwide planning capability dedicated to rational development of a coherent system of waterfront facilities along the inland waterways, riverport planning is constrained by a variety of institutional processes geared primarily to other public concerns. Governments at all levels now expend much effort to promote better coordination of planning activities. While all of these coordinative undertakings are motivated by desirable public policy objectives, they are often resource-competitive. Many of them impinge directly on the development of riverport facilities in selected areas. This chapter, therefore, examines the planning needs of river transportation from the perspective of optimum participation by shallow draft carriage in a balanced intermodal transportation system.

A FRAMEWORK FOR THE FUTURE: IMPROVING PORT PLANNING CAPABILITIES

The institutional framework for developing riverport facilities in Mid-America currently lacks a planning capability that can deal effectively with requirements and potentialities on an areawide basis. The Mid-America study represents an initial effort to define requirements and potentialities for the entire area. It provides a data base from which state and local planning can proceed. Mid-America states with the support of the Federal Government are developing multimodal planning capabilities that could make good use of such data. However, planning capabilities of public port agencies in Mid-America are so spotty and uncoordinated that the study's potential benefits may not be generally realized. The time is clearly here for an orderly, continuing program of Federal and state collaboration to promote riverport planning capability throughout the inland waterway system.

Planning activities of local port authorities in Mid-America reflect a wide range of capabilities. A few are highly sophisticated and very effective in mobilizing support for necessary waterfront development. Others have little visibility and exercise little influence on landside developments, perhaps meeting only the minimal requirements of local sponsorship for participation in Federally supported harbor and channel improvements sought by the community.

Waterway operators have suggested that planning for riverfront facilities often has low priority in state and local governments because of a fundamental incongruity between political jurisdictions and the river. As a result, public policy makers are said to have distorted, artificially segmented views of developmental requirements on the waterfront. When similar deficiencies have been identified in other areas of public concern, cooperative planning arrangements have often proven advantageous.

The nature of shallow-draft carriage, therefore, lays a special burden for cooperative planning on the mission-oriented government entities, e.g. local port authorities, state water transportation agencies, the Federal Maritime Administration, and other agencies that have statutory responsibility for promoting coherent development of riverport facilities. Harbors, channels, and landside facilities associated with a riverport may involve areas under the jurisdiction of more than a single local government. The hinterland the port serves may involve areas extending far beyond the jurisdiction or the state itself.

Port planning ought to be increasingly oriented to economic development of surrounding areas. Primary attention should focus on providing those water transportation services that will best serve the industries already in the port's hinterland and attracting new industries into the area. Basic to this concept is a regional approach to port planning that enable neighboring ports to complement each other profitably by attracting a greater range of commodities and serving more industries in wider, overlapping hinterlands.

The Federal Government has a continuing interest in encouraging planning and development of a balanced system of riverport facilities. Only through an appropriate mix of facilities along the waterfront of our navigable rivers can the nation be sure that the waterway system improvements authorized and financed by the Congress will have optimum utility. But system concepts have had almost no influence on the pattern of landside development. Local interests, sometimes parochial and competitive, have at times dominated public policy decisions regarding riverport facilities. Moreover, isolated single-purpose, privately financed terminals have been constructed in large numbers along the river with virtually no consideration of their relationship to the system.

Uncoordinated riverfront development is especially unsettling because local interests, public and private, have a very strong influence on the Federal waterway improvement agenda. Federal projects, such as harbor and waterway projects carried out by the Corps of Engineers, respond to local initiatives.*

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* See Appendix F for Procedures Governing Civil Works Projects, U.S. Army Corps of Engineers.

Altogether they represent a very large package.

STATE ROLE IN RIVERPORT PLANNING

A state government that wants to make the most of its riverport capabilities should begin by establishing a formal mechanism, if it has not already done so, for promoting rational development of riverfront facilities on its navigable waters. In short, there should be a principal state agency with clearly defined responsibility for water transportation. The principal state agency responsible for water transportation should perform the following functions:

1) Advise and assist the governor in formulating water transportation policy for the state and in coordinating port and waterway development policies and activities among other state departments and agencies;
2) Study water transportation problems and formulate proposals designed to meet and resolve water transportation problems in the state;
3) Provide financial and technical support to planning and development of inland water transportation facilities and services;
4) Provide technical assistance to local governments and port authorities on riverport planning and development;
5) Consult and cooperate with representatives of Federal, state, and local government agencies on problems affecting water transportation in the state;
6) Maintain liaison with representatives of water carriers, terminal operators, and other persons concerned with water transportation facilities and services;
7) Participate in proceedings of Federal, state, or local agencies considering regulatory action that would affect water transport in the state; and,
8) Recommend policies, programs and actions designed to improve use of the state's waterways system in keeping with the goals of the long-range statewide transportation plans.

Whatever form the state agency concerned with water transportation may take, its responsibilities should encompass the above functions. Unless these are adequately provided for, the state's participation in an integrated waterway and riverport planning effort will lack optimum effectiveness.

To the extent that a state government is interested in ensuring development of a balanced system of public and private waterfront facilities along its navigable rivers, it should encourage a systematic approach to port planning. Without state participation in the planning process it is unlikely that systems concepts will be applied to riverport planning. The role of the states in this process is essentially one of coordination. Neither the local port authority nor a Federal agency can coordinate formulation of plans for orderly, realistic improvement of riverport facilities on the navigable waters associated with the state. The state government exercises significant control over financing of public facilities at riverports, although their development depends primarily on local initiatives. Only the state governments, individually or in concert, can deal with complexities arising from the fact that the fundamental system to which riverport planning relates is not defined by political jurisdictions or state boundaries, but by the configuration of navigable streams and the flow of commerce to, on and from them.

The state government also plays a pivotal role in the integration of the public interest and private interests of transportation users. That objective will be served best if the state government actively promotes coordination of local riverport planning efforts with other regional or state planning. As a minimum, planning for an individual terminal or other facility should be integrated with areawide planning for the port complex with which it is associated and with the community's comprehensive transportation plan. These in turn should be articulated with the comprehensive intermodal planning efforts to which most states have already committed themselves.

As the economy at all levels of the public and private sectors adjusts to increasingly urgent energy supply problems, shippers will seek wider access to benefits inherent in intermodal coordination. Through their planning efforts, state departments of transportation may well be the agencies best adapted to providing leadership needed to foster development of energy-efficient transportation systems using existing facilities and equipment. Modest efforts at multimodal transportation planning and intermodal cooperation already under way in some Mid-America states should be considerably expanded. Because water transportation is inherently energy-efficient, public policy should assure that this mode will have expanding opportunities to attract new users for movement of bulk commodities.

Land use, economic development and environmental protection constitute a related body of state government concerns that are sometimes called "state policy planning". This type of planning has come into being when the state usually on recommendation of the governor, decides to define a policy with respect to key issues or needs. Its general objective is to improve decision-making and allocation of resources by the governor, the legislature, or other policy makers.

A state-level policy planning process now exists in most Mid-America states. The White House Conference on Balanced National Growth and Economic Development, January 1978, was told that plans and policy guidelines had been completed by twelve Mid-America states: Alabama (1975); Arkansas (1976); Illinois (1977); Iowa (1974); Kansas (1978); Kentucky (1977); Minnesota (1977); Nebraska (1977); Ohio (1977); Oklahoma (1977); Pennsylvania (1977); and Tennessee (1977). Similar policy guidelines were reported to be under development in Louisiana, Mississippi, Missouri, and Wisconsin.

Growth and energy policies of these states will surely have increasing influence on the interplay of public and private investment decisions that govern waterfront development. Yet state riverport plans are virtually nonexistent.

The low level of state planning to guide development of riverport facilities is particularly incongruous because state planning for other transportation modes is relatively advanced. Federal sponsorship through grants-in-aid unquestionably accounts for the prevalence of state planning for other modes. Federal support is basic to the Federal-state highway program, which has historically included statewide highway planning. Promoting "effective location and development of airports" is a Federal interest in pursuit of which the Federal Aviation Administration makes grants to support airport system planning and airport master planning (49USC1713). Federal support of urban mass transit projects is contingent upon the conduct of "a continuing, cooperative and comprehensive planning process" in the participating states and local communities (49USC1602). More recently eligibility to receive rail service continuation assistance from the Federal Government has been made contingent on development of a State Rail Plan.

LOCAL ISSUES AFFECTING RIVERPORT DEVELOPMENT

Planning for riverport facilities should be viewed as a major element in the community's planning and development. The port is a major consumer of the community's natural resources, a significant environmental influence, a generator of substantial economic activity, and a partner with other surface facilities for the movement of goods.

Developing consensus among various constituencies in the port community is emerging as one of the significant challenges to riverport management when it wants to develop a new port or expand port facilities. Planning for physical development for a new port or significant expansion of an existing facility will sooner or later arouse widespread interest among private citizens, community organizations, areawide planning agencies, environmental groups, and transportation agencies.

In the past, port administrators have faced similar challenges only when it was necessary to go to the voters for approval of a bond issue.

Land use, public health, and environmental controls associated with increasing urbanization of our society now make consensus building more critical and time-consuming. Like rallying support for a bond issue, consensus building is the political manifestation of good planning. Most of the difficulties this entails will have to be resolved locally.

While port and waterway people are fond of saying that political and economic realities will force a retreat from "environmentalism", few anticipate that there will be any significant relaxation of public demand for minimizing environmental degradation. However burdensome specific administrative regulations may be, it is most unlikely that national and state policies will abandon protection of water quality or conservation of wetlands as important societal objectives. Expeditious development of port projects, like other large scale facility developments, will therefore benefit from addressing environmental considerations from the very beginning of the planning effort and the early integration of port facility planning with other aspects of community development. The trade-offs, compromises, and shifting coalitions that characterize such a planning operation are eventually reflected in port facilities that elicit public support because of the clearly recognized public purposes they serve.

The statutes of several states already define the planning responsibilities of port authorities with considerable specificity. Typically such laws require that the board of directors of a port authority must prepare "a plan for the future development, construction, and improvement of the port and its facilities, including such maps, profiles, and other data and descriptions as may be necessary to set forth the location and character of the work to be undertaken." They may require that information concerning the plan must be published for several consecutive weeks in a general circulation newspaper in each county or other political subdivision participating in creation of the port authority. They may require that owners of uplands contiguous to submerged lands affected by the plan be served notice similar to that given in levies of special assessments by the local government. Such public notice generally must provide for public hearing of all objections to the plan and filing of written objections. Sometimes, as in Kansas and Ohio, the statute provides that if a specified percentage of persons owning real property contiguous to the proposed port object to the plan, a revised plan is to be developed.

Unilateral facility planning is no longer feasible even at the riverport itself. To deal adequately with all aspects of environmental protection requires a wider cooperative effort. A local port authority can ordinarily rely on its own resources and river-related affiliations in coping with the effects of facility operations, e.g. spillage, discharges, or vessel movements. Available technology can handle most tangible pollutants. Mission-oriented Federal and state agencies can provide technical aid, if needed. However, conflicting land-use and aesthetic demands are amenable only to institutional solutions that: (1) take into account other uses and constituencies in the community; and (2) develop trade-offs compatible with community consensus.

Expansion or new construction of facilities involving, in particular, receipt, storage, and shipments of bulk commodities typically raises such issues. In contrast to general cargo facilities, bulk operations are likely to raise concerns about existing air and water pollution problems of the community. It may put large new demands on water supply and waste disposal systems. It may conflict with an urgent community desire to develop recreational potentialities along the river. The experience of some highly developed ports on inland rivers suggests that such problems are best dealt with in consonance with the larger community's planning and governance.

FEDERAL PARTICIPATION IN RIVERPORT PLANNING

The Federal Government should encourage coherent, system-wide planning for riverfront facilities on navigable inland waterways. This effort should aim at improving state and local capabilities for preparing integrated plans to which public and private facility investment decisions can be related. As the agency historically responsible for promoting water transportation, the Maritime Administration should be directed to provide leadership and technical assistance to the effort.

A cooperative Federal, state and local inland waterway program should include as a primary objective the balanced development of a network of riverport facilities adequate to meet the present and future needs of inland water transportation. This involves several corollary objectives to which national, state and local planning should be directed. It includes placing barge transportation in its proper perspective in relation to a balanced multimodal transportation system and to other comprehensive planning efforts sponsored by the general governments along the waterways. The program should give consideration to optimal use of land and waterfront resources consistent with the growth patterns defined in each participating community's comprehensive planning program; and, in the absence of such a program, it should identify for the appropriate general government officials the impact of proposed port development on other aspects of community life. Finally, the program should protect and enhance the environment along the waterway by ensuring that waterfront and harbor development is carried out in such a way as to avoid ecological impairment.

The Congress has found it "in the national interest to encourage and promote the development of transportation systems, embracing various modes of transport in a manner that will serve the States and local communities efficiently and effectively" (23 U.S.C. 134 and 49 U.S.C. 1602). It has applied this principle to planning for intercity transportation by highway, rail, and air and to urban mass transit planning as well. The Mid-America Ports Study demonstrates that comparable national interest exists with respect to the facilities needed for inland water transportation.

The Maritime Administration should promote effective location and development of riverports with a view to ensuring an adequate riverport capability on the nation's navigable inland waters. To accomplish this, the agency should be authorized to make grants of funds to the states for (1) development of state port plans, (2) support of areawide riverport planning, and (3) integration of port master plans with other community and state transportation plans.

One of the primary benefits to be obtained from a modest outlay for coordinated riverport planning is integration of a host of Federal water-related transportation investments already authorized. As indicated in Chapter 11, these funds are associated with a variety of programs administered by separate Federal agencies in pursuit of discrete objectives and mission assignments.

The states should provide for administration of the proposed port facility planning grants by the state agency to which the governor looks for comprehensive multi- and intermodal transportation planning. A part of each state's grant might well be used to help finance preparation of a state port plan consistent with the authorized inland waterway system. However, the principal emphasis should be on substate areawide port planning. In similar situations, authorizing Federal legislation has sometimes provided that a specified percentage of the Federal dollars granted to the state must be made available to the appropriate local or substate agencies. The state government should in any event be the channel for giving riverport planning support to areawide planning agencies, multicounty port authorities or planning commissions, voluntary associations of local governments, or joint agencies to which two or more local governments have delegated areawide port planning authority.

The riverport planning process at all levels -- state, local and intermediate (areawide) -- consists basically of the same elements.

AREAWIDE RIVERPORT PLANNING

In view of the extraordinary contributions shallow-draft water carriage can make to a more efficient intermodal transportation system, the Federal Government should actively promote cooperative Federal, state and local riverport planning and the development of areawide riverport plans for waterfront facilities on navigable inland waters. For maximum effectiveness the program should be carried out under the leadership of agencies already responsible for related matters. Within the Federal Government, this leadership should emanate from the Maritime Administration, which already has statutory responsibility for promoting port development. The Administration should be given the mission and resources to help the state establish adequate areawide riverport planning capabilities along major segments of the navigable waterways.

An areawide port facility planning process would involve the preparation of policies, plans, and programs to establish a viable, integrated network of riverfront facilities and supporting services adequate to meet the needs of commerce on a segment of the navigable waterway defined as the planning area.

Organizational responsibility for areawide riverport planning would vary from one state to another in accordance with existing state arrangements for dealing with water transportation. Other variables associated with organizing the planning process include: (1) the pattern of ownership of or control over existing waterfront facilities in the planning area; (2) scope and effectiveness of comprehensive planning programs already underway in the area; (3) statutory missions of the participating agencies; and (4) financial resources available to support the planning effort.

Although the required planning capability does not now exist, certain in-place arrangements constitute a set of resources on which a comprehensive port planning capability can be built. The Maritime Administration's research studies, e.g. the Mid-America Ports Study itself, are creating a sound information base for such a program. Virtually all of the states with inland waterway frontage already have mechanisms for comprehensive transportation planning or for more generalized policy planning that embraces transportation along with economic development, land use and other related matters. Areawide planning agencies already exist in several substate forms - councils of government, regional planning commissions, and economic development districts among others. Intergovernmental enterprises, e.g. the Bi-State Development Agency serving the St. Louis metropolitan area, have already applied appropriate planning methodology to riverport problems.

The goals of areawide port planning on the inland waterways should include:

- Orderly and timely development of riverfront facilities to serve the present and foreseeable water transportation needs of the area;
- Defining the role of barge transportation in a balanced multimodal transportation system for the community;
- Coordinating plans for riverport facilities with other local, regional, and state planning efforts;

- Providing a framework for port-related private sector development on the waterfront;
- Developing the riverport elements of long-range fiscal plans and establishing appropriate priorities for financing port-related public works in the budgets of associated governments;
- Optimum use of the community's waterways and waterfront lands;
- Affording civic entities affected by the port an opportunity to participate in planning for waterfront development; and
- Sound technical and economic information for local participation in proposed harbor and waterway improvements.

Organizing for Areawide Port Planning

Since riverports are major users of land and other resources in the communities they serve, organizing for areawide riverport planning is a crucial part of the planning process itself. Its hallmark is coordination with other policy-making and planning efforts in the affected communities. Such coordination may be achieved through merging of the planning efforts or through fully informed parallel action.

The agency designated to perform the actual planning should have specific capabilities for this work. It should be able to establish policies that are credible and politically acceptable. It should be capable of eliciting advice and cooperation from: (1) various components of the water transportation industry and other surface modes; (2) waterfront industries and other users of transportation services; and (3) recreational, environmental or other interests concerned with the waterfront. It must be able to administer a technically sound, professional planning effort while maintaining responsiveness to the relevant policy guides of general government. Unless these criteria are met, areawide planning for port facilities is likely to be ineffective.

In seeking an agency to perform areawide port planning it will probably be necessary to look beyond the general government structure. There is probably no general government, e.g. a county, that embraces a logical intermediate-level port planning area. Among existing bodies that could provide policy, administrative, and technical direction to the effort the most likely candidates are multi-county or regional planning commissions, councils of governments with professional planning staffs, or state-sponsored areawide planning agencies. Regional organizations with a primary interest in intermodal transportation planning have been established in some areas with the help of planning funds provided through the Federal-state highway program. Section 134 of the Federal-Aid Highway Act of 1962 (Title 23, U.S.C.) provided that highway projects must be based on a continuing comprehensive transportation planning process. In some states this program is no longer exclusively highway-oriented.

An existing port authority or a city/county planning commission with appropriate geographic jurisdiction may be able to do the port planning job best in its area. Where a group of local port authorities are already organized under an umbrella organization, as in the Port of Metropolitan St. Louis, the existing agency should be fully utilized. In the absence of such an organization, a group of port authorities having contiguous jurisdiction or sharing a common river might wish to associate themselves in a common planning effort.

Wherever there is an existing planning agency with compatible objectives or congruent jurisdiction, the local port authorities could rely on it for management of the areawide port planning effort. In any event, local port authorities should devote their planning resources to developing master plans for their respective ports, planning and supervising development of specific port projects, cooperating with the Corps of Engineers and state public works agencies in completing authorized harbor and waterway improvement projects, and providing appropriate inputs to the areawide planning process. The recommended relationships among plans developed by various agencies are shown in Figure 40.

Cooperative and systematic planning will help achieve two major benefits -- rationalizing development of waterfront facilities and stimulating action to develop facilities where they are most needed. Some development occurs in any event as local agencies, public and private, respond to disparate initiatives and perceptions of need. However, the best way to mobilize the increasingly limited resources of state and local communities is to lay before their decision-makers a set of practical and coherent plans to which development and financing of individual projects can be related.

INTERSTATE ENTERPRISES

Navigable waterways of the Mississippi River and its tributaries often serve as the boundaries between states. Metropolitan areas and the port complexes that serve them tend to straddle such boundaries, thus falling under the jurisdiction of two or more states. For areawide planning purposes a cooperative interstate effort may optimize the available benefits in such areas.

An interstate compact authorized by the Constitution of the United States is the recognized means by which two or more states can act in concert on problems that involve state and local interests in an area that involves more than one state. The compact is a versatile and potentially very effective form of intergovernmental cooperation. It is wholly consistent with our Federal-state system -- a flexible instrument that makes full use of existing governmental structures rather than bypassing them.

Establishing a multi-state authority for any purpose requires parallel legislation by the cooperating states and approval by the Congress of the United States. The need for such an agency generally derives from a shared concern for orderly development of resources or service systems in a metropolitan area that includes local units in two or more states.

Port and waterway facilities on a river that marks the boundary between states are logical candidates for joint planning, development, and administration through a multi-state authority. Experience with such agencies suggests that if local differences and aspirations can be sufficiently reconciled to create an interstate authority, its responsibilities are likely to extend beyond port and waterway development into other river-related concerns, e.g. water supply, pollution abatement, recreational facilities, and land use patterns. Other transportation responsibilities often revolve on such multi-state authorities, some of which operate and maintain bridges, tunnels, airports, and urban transit systems.

Two major multi-state authorities with port planning responsibilities are currently in operation in Mid-America. Since they represent entirely different approaches to use of the interstate compact as a means for promoting port and waterway development, they are described for purposes of comparison in Appendix F.

Institutional arrangements associated with the Port of Metropolitan St. Louis are particularly noteworthy in the context of this study. The metropolitan area has seven independent local port authorities, four being in Missouri and three in Illinois. In 1975 the Bi-State Development Agency was designated as the regional port coordinator for the area. In this role the Agency is responsible for coordinating implementation of areawide port development plans.

VOLUNTARY ACTION BY INLAND PORT COMMUNITIES

Among other things, the Mid-America Ports Study itself has demonstrated clearly the usefulness and practicality of voluntary coordination in planning for riverport facilities on our inland waterways. However, the developmental program for which this study sets parameters has little likelihood of effective implementation without areawide coordination among local port officials and those who operate related private facilities. The risks of expensive duplication, of unused capacity on a given stretch of river, or of inadequate facilities for handling potential traffic at other points are far too great to be left entirely to government agencies. Most waterfront facilities will in any case continue to be financed through private investment. The governmental interest should be manifested primarily in the balanced development of effective intermodal facilities.

Balanced development will be facilitated by direct and reasonably continuous interchange of information among the agencies in which plans for riverport development originate and those who will implement the plans and use the facilities. Such coordination can be accomplished within the context of a professionally-oriented association, through which port officials and the users of port facilities can examine system-wide problems and options for solving them without the constraints inherent in governmental structures. These considerations strongly suggest the desirability of participation in the policy formulation process by voluntary association of those most directly concerned with and most fully informed about problems of riverport development.

Articulation of needs and informed advocacy are both vitally necessary to decision making in democratic government. They involve activities that are essentially nongovernmental. Because wide public support is necessary for political viability of recommendations for publicly supported port system improvements, the association should encourage participation of all who have a professional or trade interest in riverport planning, development, and administration.

If a voluntary association of Mid-America port officials is formed to pursue these objectives, the Federal government and the states should view it as another channel of communication through which the agencies can receive areawide information and advice, as well as a possible means of disseminating information and technical assistance with respect to regional and areawide port facility requirements and opportunities of which the government becomes aware. The manner in which Federal and state governments deal with such an association can be a crucial factor in its development as a healthy partner in democratic deliberation and decison-making on development of waterfront facilities.

There is already in existence a nonprofit corporation chartered by the State of Missouri, whose stated objectives are consistent with the need for a voluntary association of the type suggested here. Inland Rivers Ports and Terminals, Inc., has defined its objectives and purposes as follows:

- To promote and develop the healthy growth of the inland rivers, ports and terminals through the exchange of information and coordinated action in all matters affecting their common interests.
- To promote and develop improved services to shippers.
- To promote and aid in the development of a more efficient intermodal national transportation system.
- To promote and encourage foreign and domestic commerce to and from all inland river ports and terminals.
- To promote and encourage the development of waterborne transportation.
- To promote river and port-related commercial and industrial development through the preservation and economic development of suitable lands adjacent to the navigable waters of the United States.

Inland Rivers Ports and Terminals, Inc., recognizes varying regional interests by electing members to its board of directors from seven areas along the waterways: (1) Upper Mississippi, (2) Illinois River, (3) Missouri River, (4) Ohio River, (5) Cumberland-Tennessee-Tombigbee Rivers, (6) Lower Mississippi, and (7) Arkansas-White Rivers. Should this organization choose to take the leadership in representing the interests of waterborne commerce in the development of riverport facilities in Mid-America, its regional approach could serve well as the basis for integrating the non-governmental response to various Federal, state, and local facility development plans.

To serve the required coordinating and advocacy needs from an extragovernmental prospective, the recommended voluntary association should develop a capability for providing reliable and timely information that will enable policy makers in Federal and state governments to deal effectively with the entire range of issues affecting shallow-draft water carriage in Mid-America. For practical purposes such an issue exists whenever the parties affected by a problem can discern no ready solution. This typically obtains when the solution of a problem depends on negotiated results, as in conflicts between the public interest and a private interest or when questions of equity must be resolved.

Many of the major problems that present such issues involve governmental uncertainties. A voluntary association of inland port spokesmen can help to clarify and resolve many of the problems that complicate public policies with respect to inland water transportation. Typical examples include:

- Role of the Federal Government in relation to (1) financing and user charges for navigation improvements and (2) long-term Federal responsibility for maintenance, repair and upgrading of waterways;
- Economic and regulatory programs administered by the Federal and state governments, which may tend to distort competition both between and within transportation modes, thereby promoting inefficiency;

- Multiplicity of Federal agencies, each of which may affect waterway and riverfront development in ways not foreseen or appreciated by Federal policy makers;
- Multiple-use concepts arising out of conflicting demands for water resources, which in some areas of Mid-America may become especially difficult when water scarcity required allocation (as between navigable and irrigation or industrial withdrawal);
- Consensus on systems concepts as a basis for (1) planning an efficient, intermodal transportation system and (2) an integrated inland waterway and riverport system;
- Capital formation requirements, which involves an industry-wide understanding of the capital base needed for operating effectively in a fully developed inland waterway and riverport system; and
- Changing social objectives, to which the waterway and riverport community can make significant contributions, including those of current national interest, e.g., energy production and conservation and environmental protection, and others that may arise in respect to access to service (or the right to service) and the role of competition and market-place decisions in transportation.

IMPACT OF USER CHARGES

Enactment of the Inland Waterways Revenue Act of 1978 imposes a tax on fuel used in commercial transportation on the inland waterways in accordance with the following schedule:

October 1980 - September 1981	4 cents/gallon
October 1981 - September 1983	6 cents/gallon
October 1983 - September 1985	8 cents/gallon
After September 1985	10 cents/gallon

In general, the tax applies to fuel used by any vessel engaged in transporting goods for compensation or hire or any vessel that the shipper directly or indirectly owns, leases or operates for the transportation of goods on the inland waterways.

The act also directs the Secretary of Transportation and the Secretary of Commerce, in consultation with the heads of other executive departments and agencies, to make a full and complete study with respect to waterway user taxes and charges, and to make findings and policy recommendations with respect thereto. The study must give consideration to the taxing mechanism, economic effects of waterway user charges, economic feasibility of waterway improvement projects and the comparative levels of benefits expected from Federal investments on inland waterways, and effects of waterway user charges on future Federal development policies. The final report on this study must be submitted to the Congress by September 30, 1981.

Timing of the required study presents some difficulties. The interdepartmental study will be done during the period in which the 4-cents-a-gallon tax is in effect, but its adverse impact will not yet have become visible. Industry representatives believe that it takes about five years for such effects to become clear. The required study will have to be done without benefit of a "track record". Moreover, during the five years in which the impact is being registered in the facility investment and planning process, the biennial tax rate increases will have compounded the difficulties of developmental decision makers.

The mandate requiring this interdepartmental study of waterway user charges should be expanded to include a biennial review and reports to each successive Congress until 1991, when the effects of the 1978 legislation may have stabilized.

SUMMARY

Riverfront facilities in Mid-America reflect some impressive planning achievements by local port authorities. Since World War II, technical quality of project planning in riverports has shown steady improvement. In addition, major inland ports typically have good master plans. However, system capabilities cannot be adequately addressed by individual ports or terminals, which are often fiercely competitive with their closest neighbors on the same reach of river.

To achieve an optimally efficient system of waterfront facilities for shallow draft carriage on inland waterways requires more carefully focused cooperative planning. Without such attention the entire riverport community will be disadvantaged in the years ahead.

State transportation plans are being promulgated throughout Mid-America, but they generally lack a meaningful riverport component. Inland port planning is already at a disadvantage in relation to other resource-competitive planning activities. With both Federal and state encouragement, broadly based community planning efforts are creating an increasingly definitive and constraining framework of land use controls, multimodal transportation systems, and regional economic improvement programs. The requirements of river-related commerce and industry must be presented persuasively in the context of regional planning. Mid-America needs shallow draft carriage. An adequate system of landside facilities along the navigable waterways is an essential ingredient of an efficient national, state and regional transportation network.

Cooperative and systematic planning will help achieve two major benefits -- rationalizing development of waterfront facilities and stimulating action to develop facilities where they are most needed. Some development occurs in any event as local agencies, public and private, respond to disparate initiatives and perceptions of need. However, the best way to mobilize increasingly limited resources of state and local communities is to lay before their decision-makers a set of practical and coherent plans to which development and financing of individual projects can be related.

In brief, riverport planning should be better coordinated, intensified and made more effective at state and local levels and also at the intermediate areawide level. A reasonably coherent system of waterfront facilities along the navigable inland waterways is clearly in the best interests of the nation and the states served by these waterways. The Federal Government should, therefore, encourage states to develop riverport plans for their respective portions of the inland waterway system. Such plans should complement the intermodal transportation plans many states have already initiated. If not incorporated as a component of the state's comprehensive transportation plan, the state port plan might be developed by the principal state agency for water transportation and coordinated with other modal plans through state-designated channels. In any event, states should give responsible leadership to preparation of riverport plans for appropriate substate areas, either through their regional planning programs or other arrangements.

As the Federal Government's agent for promoting water transportation, the Maritime Administration should be directed to provide research and analytical support for the achievement of an increasingly efficient system of locally owned and administered waterfront facilities to complement the inland waterway system.

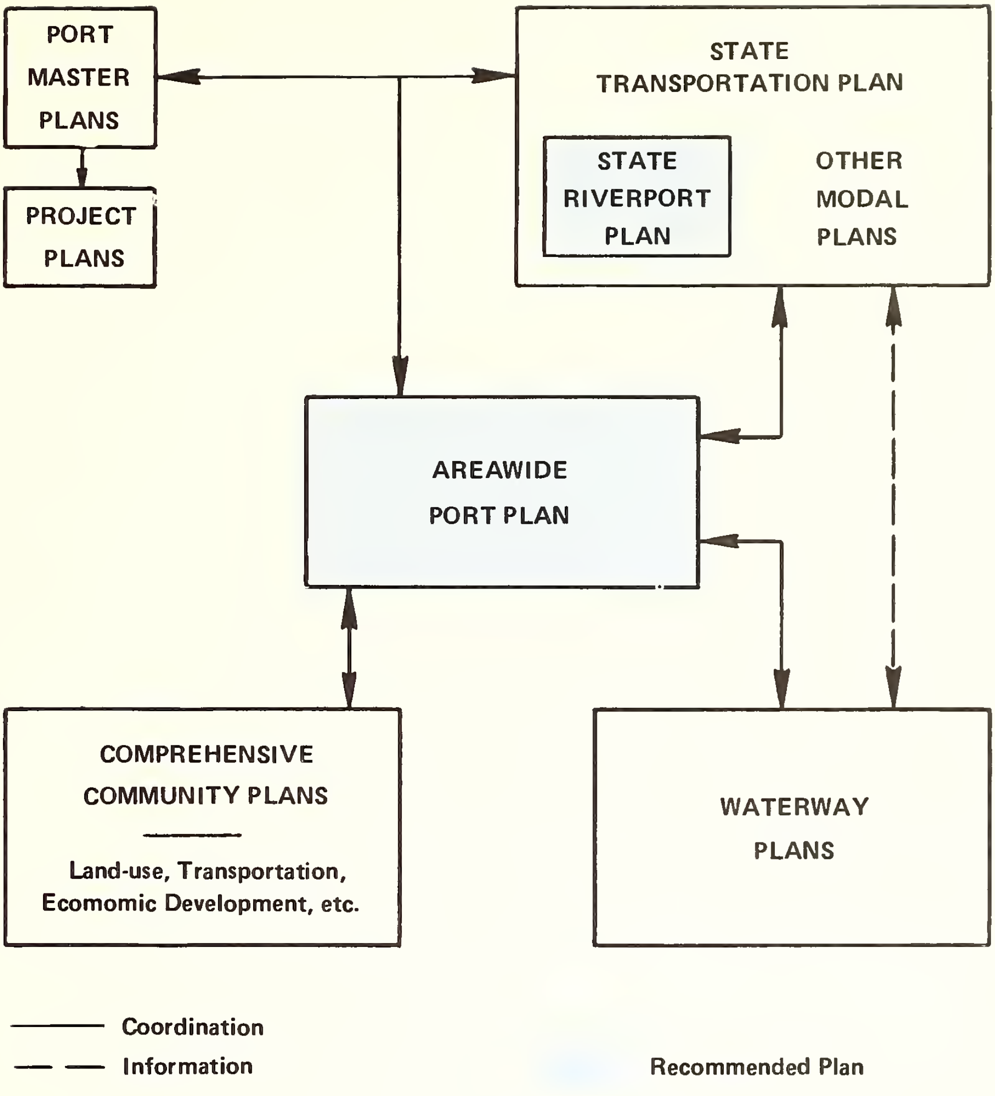

PORT MASTER PLANS
PROJECT PLANS
STATE TRANSPORTATION PLAN
STATE RIVERPORT PLAN
OTHER MODAL PLANS
AREAWIDE PORT PLAN
COMPREHENSIVE COMMUNITY PLANS
Land-use, Transportation, Ecomomic Development, etc.
WATERWAY PLANS
Coordination
Information
Recommended Plan

FIGURE 40 RECOMMENDED RIVERPORT PLANNING SYSTEM

CHAPTER 20

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 20

CONCLUSIONS AND RECOMMENDATIONS

By the year 2000, cargo at Mid-America's ports will exceed existing capacity by almost 700 million tons annually. Significant capital investments will be required to accommodate these major increases and shifts in waterborne commerce. Coal alone will account for about 35 percent of the capacity deficiency; the utilization of the waterways system for the movement of western coal to midwestern and southern markets will require new handling terminals. Major new facilities will also be required for grains, petroleum products, fertilizers and construction materials.

These needs are translated into investment, number of facilities and land requirements. Through the year 2000, the construction of new facilities to accommodate forecast commodity growth will require a capital investment of almost $9.5 billion, of which 40 percent will be expended in the State of Louisiana. This money will be needed for the construction of 1,000 new terminals and the development of 11,000 acres of land; additional acreage will be utilized by the industrial facilities served by these terminals. Over 100 miles of waterfront will be occupied by the new terminal facilities.

Major investments will be made for facilities handling the following commodities: petroleum products -- $4.4 billion; coal -- $2.2 billion; cash grains -- $1.4 billion; fertilizers -- $900 million, and chemicals -- $770 million. Additional investments will be needed for barge fleeting and other facilities that support water transportation.

The Mid-America facility inventory currently contains 1,200 inland port terminals and the analyses performed in this study indicate that this number will double by the year 2000. There is strong justification for a more aggressive, structured

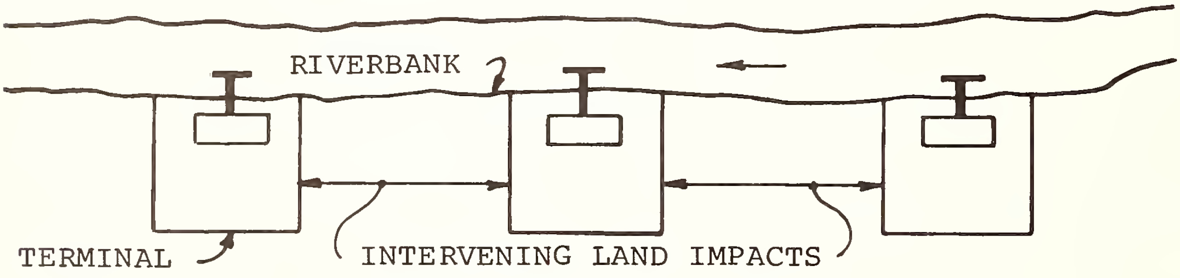
Federal-state-local riverport planning process involving both the public and private sectors. The process should insure that increasingly scarce waterfront land is available for the development of these new facilities and that their construction is compatible with the environment and consistent with regional and statewide development programs.

These concerns are addressed below.

RECOMMENDED FACILITY PLANNING

Development along the inland waterways has historically occurred in haphazard fashion and waterfront terminal sites are generally strung out along the river bank. In large measure, the sites were selected to suit the convenience of private users who considered such factors as rail and truck access, land and development costs and distribution and marketing conversation; the environment and regional development objectives often were not considered.

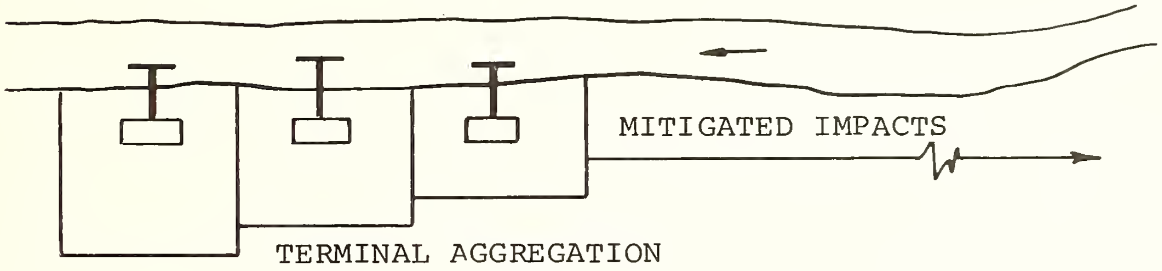
As a result of the above, the existing pattern of haphazard riverport development, characterized by the following sketch, is common on the inland waterways.



EXISTING DEVELOPMENT PATTERNS

Terminal facilities have an influence upon adjacent lands which transcend their immediate boundaries. The integrity of intervening land uses, particularly for recreational and conservation activities, can be seriously compromised by the industrial and commercial development associated with riverports. Each terminal has the potential to adversely impact adjacent uses. It is not uncommon for long reaches of undeveloped riverfront suitable for residential, recreational or conservation use to be interspersed with river terminals.

The adverse impacts upon land use patterns may be mitigated by aggregating terminal development along a reach of river, as depicted in the following sketch.



PROPOSED DEVELOPMENT PATTERN

In addition to having a positive impact upon the environment and land use, facility aggregation results in cost savings for such services as towing, fleeting, security and U.S. Coast Guard services for oil spill cleanup and firefighting. These are costs which are borne largely by the shipper and the public sector, rather than the terminal operator. As noted in Chapter 17, capital cost savings arising from such aggregation would be modest, resulting largely from economies of scales associated with site development, access and utilities connections.

As suggested herein, each owner in the recommended development pattern would retain use of his own material handling equipment and barge berth. This permits full flexibility of operation. The owner is unencumbered by the need to "share" conveyance equipment or berths; state-of-the-art technology would be used. In contrast, an alternative development proposal involving consolidated waterfront industrial parks with a single berth requires that tenants share common equipment of relatively sophisticated technology.

Aggregation of facilities as a waterfront planning objective can be pursued within the framework discussed in Chapter 19 and further elaborated upon in this chapter. Certain types of commodity handling facilities lend themselves to this type of development more readily than others. Table 20-1 indicates which commodity groups, by virtue of their handling characteristics and industry interrelationships, are likely candidates for grouping. By utilizing this table in association with the projected subregional facility needs presented in Appendix K, each state and/or local agency can prioritize its waterfront planning and programming objectives along the lines recommended herin.

RECOMMENDED INSTITUTIONAL STRUCTURES

The following summarizes the institutional recommendations described more fully in Chapter 19.

Federal, state and local government policy on waterway and riverport development in Mid-America has had considerable stability resting in part on tradition. Federal regulatory policy is exercised in accordance with the Constitutional prohibition against preference to ports of one state over those of another. Developmental responsibility for channels and harbors remains essentially with the Congress, which has only recently adopted the principle of user charges to finance a portion of the future costs of the waterways. Development of riverport facilities continues to rest entirely on state and local, often private, initiatives.

National policy on riverports is practically nonexistent. And stated policies have seldom been vigorously applied. A policy calling for publicly owned terminals at all cities on navigable waterways of the United States has been on the statute books since 1919. Its effect on Federal actions has been scarcely perceptible.

Section 8 of Merchant Marine Act of 1920 clearly contemplates promotion, encouragement and development of port and transportation facilities on the inland waters of the United States. The Mid-America Ports Study, therefore, represents a significant step by the Maritime Administration in that direction.

Historically riverport development in Mid-America has been accomplished mostly by local jurisdictions and private interests, with state governments providing little or no assistance. However, many states are now taking an increasingly active role in encouraging or guiding development of waterfront facilities. Despite wide variations from one state to another, the state government's influence is felt increasingly in the context of multi-modal transportation planning (exclusive of riverport planning), land-use controls, environmental safeguards and economic development efforts.

In addition to demonstrating the importance of reliable planning data for riverport planning, this study highlights the need for making these data available in timely fashion to policy makers at all levels of government. It also brings into focus the need for a more carefully articulated riverport planning capability throughout Mid-America. The time is clearly here for Federal and state collaboration in fostering coordinated port improvement programs if shallow-draft water carriage is to make its optimum contribution to the nation's growing transportation requirements.

The following recommendations are aimed at creating an integrated riverport planning system for Mid-America. They are based on the well-established American practice of giving Federal and state support for specific modal participation in comprehensive multi-modal transportation planning. Such Federal support has been an integral part of state and local planning since 1962. The recommendations are grouped by category of participant to whom they apply.

Federal Participants

The Federal government should encourage coordinated, systemwide planning for riverfront facilities on inland waterways maintained and improved by the Federal government. As the Federal agency primarily responsible for promoting water commerce, the Maritime Administration should monitor and document development of port facilities on the inland waterways. Promoting and encouraging development of an adequate port capability on the nation's navigable inland waters should be defined specifically as part of the Maritime Administration's mission.

Through the Secretary of Commerce, the Maritime Administration should be authorized to make planning grants to states for:

a. Preparation of state plans for development of riverport facilities adequate for the needs of commerce on the state's navigable inland waters;

b. Support of areawide port planning capabilities in multi-county port authorities or planning commissions, councils of governments, or other joint agencies to which a group of local governments have delegated areawide port planning authority; and,

c. Integration of port master plans with other areawide community development plans and with the state's comprehensive transportation planning process.

The Maritime Administration should also be authorized to provide research and analytical support to cooperative Federal, state and local riverport planning efforts and to develop and disseminate related technical guidance and criteria.

Federal support of riverport planning activities should leave responsibility for initiating actual development of waterfront facilities clearly with local governments, the port officials associated with them, and private enterprises in the port community. That is where that responsibility has always rested throughout our history. As in other matters of local concern, the Federal role should be to encourage, to aid and to provide information.

State Participants

Each state on the inland waterway system should establish or designate a principal state agency that will be responsible for promoting orderly development of riverport facilities on its navigable waters. That agency should be directed to foster a systematic approach to port planning by local governments and substate planning agencies. It should ensure that local port plans and related community transportation plans are articulated with the state's intermodal planning. The governor's support in this may be critical. As a minimum, it would be desirable for the governor to direct all appropriate state agencies to encourage and promote multi-modal transportation planning and intermodal coordination of transportation services.

The state's principal agency for port development should administer or coordinate the use of port facility planning grants made by the state or Federal governments. It should provide leadership in establishing an areawide port planning process in appropriate substate regions. The principal state agency should cooperate with its counterparts in other state governments and with the Maritime Administration in promoting effective riverport planning and in the collection and dissemination of relevant data to support such planning. This collaborative effort might well be an extension of the steering committee's work in this study. A "standing conference" of state riverport officials, might be the continuing framework for such an undertaking.

Local Participants

Local port agencies should ensure that planning for individual terminals and other port facilities is integrated with areawide planning for the entire riverport complex and the adjacent waterfront. They should also provide the local leadership that coordinates preparation of the port's master plan and its various implementing project plans with the community's comprehensive transportation planning process. Since development of the port's master plan is clearly a local responsibility, the local port authority must serve an educational and interpretive function in the community. It should encourage officers of the general governments in the area to include planning for riverport facilities as a distinctive element of community planning and development along the navigable waterways and to adopt appropriate regulations to encourage implementation of such plans.

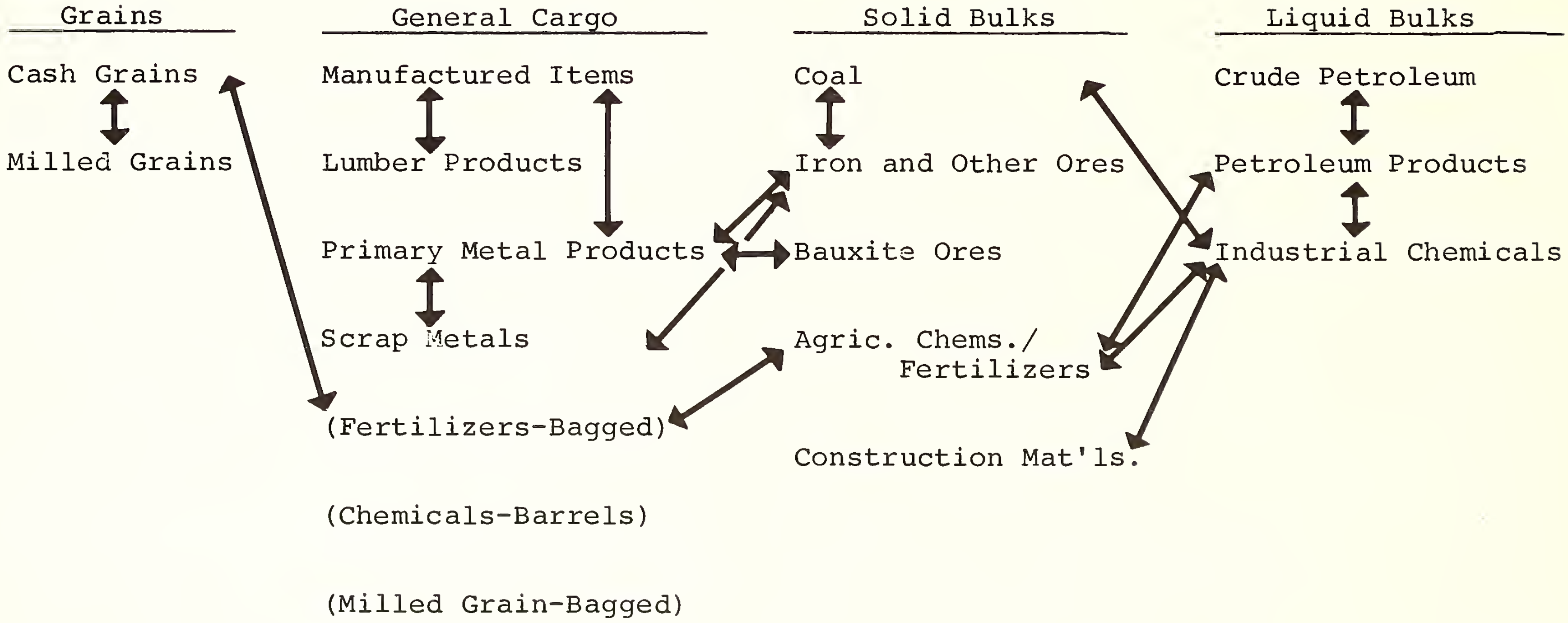
Environmental concerns should be addressed early in every port facility planning effort. The local port agency should assure that its plans are integrated with other aspects of community development, including multiple use of waterway and waterfront resources.

Local port authorities and commissions are indispensable participants in effective areawide riverport planning. They should provide data and technical advice necessary to full consideration of the needs of shallow-draft carriage in the planning area.

Local port authorities and commissions should also encourage the private sector to plan and construct facilities in accordance with port master plans.

TABLE 20-1

AGGREGATION OF PORT FACILITIES BY COMMODITY HANDLING AND INDUSTRY RELATIONSHIPS


Grains
Cash Grains
Milled Grains
General Cargo
Manufactured Items
Lumber Products
Primary Metal Products
Scrap Metals
(Fertilizers-Bagged)
(Chemicals-Barrels)
(Milled Grain-Bagged)
Solid Bulks
Coal
Iron and Other Ores
Bauxite Ores
Agric. Chems./ Fertilizers
Construction Mat'ls.
Liquid Bulks
Crude Petroleum
Petroleum Products
Industrial Chemicals

Note: Arrow indicates potential industry interrelationships.

Mid-America Ports Study

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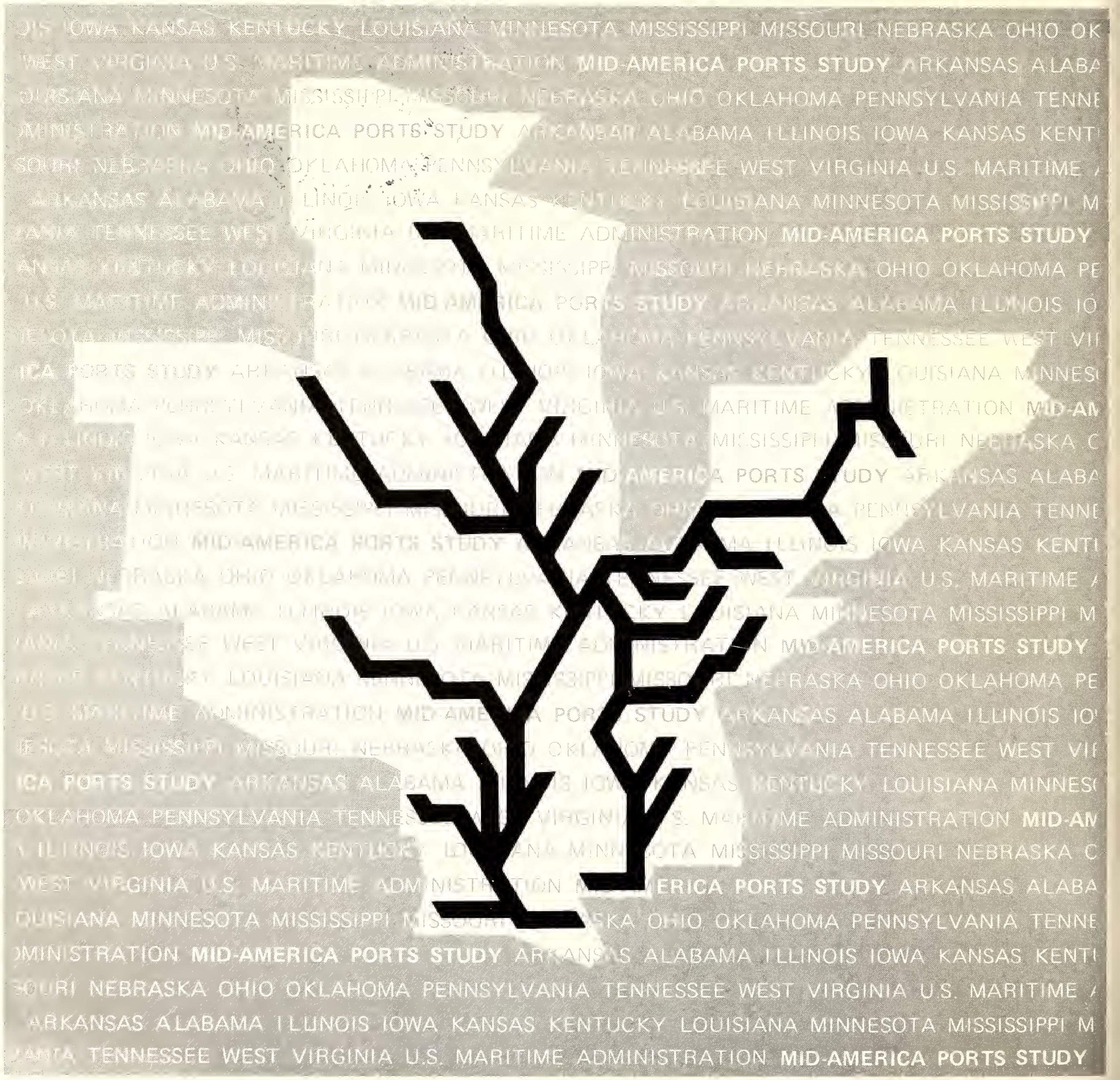
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